EXPLORING EXTREME DISRUPTIONS AND RESILIENCE CAPABILITIES IN FASHION SUPPLY CHAINS

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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Date: 22.01.2024

Signature:

ABSTRACT

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With globalization and the advent of technological developments, as well as rapidly changing trends and growing demands, there has been great pressure on the fashion industry, which forces companies to focus on supply chain management more than ever. While matching supply and demand is already a very challenging problem because of the market volatility in the fashion industry, with the disruptions that occurred in the global market over the past decade, both internally and externally, fashion retail companies encountered a series of difficulties which eventually led to breakdowns in the supply chain. Since the supply chain's success depends on its capacity to adapt to such changes, with the recent coronavirus outbreak, building a resilient supply chain becomes more important than ever for mitigating such risks while having a competitive advantage. The recent COVID-19 outbreak unveiled the shortcomings of existing supply chains globally and, accordingly, revealed the necessity of building resilient supply chains. Therefore, the aim of this thesis is to explore how disruptive events, particularly extreme disruptions such as the recent

COVID-19 global pandemic and climate change, have affected fashion supply chains while investigating the supply chain capabilities implemented by fashion companies. In this regard, a systematic literature review is conducted first, followed by semi-structured interviews with selected fashion companies and news content analysis. Following the qualitative study, a mathematical model is developed to cluster fashion companies and supply chain capabilities revealed from the interviews, thereby providing empirical insights into the development of resilience strategies.

Keywords: Resilient supply chains, fashion industry, supply chain disruption

ÖZET

MODA TEDARIK ZINCIRLERINDE EKSTREM AKSAMALARIN VE DIRENÇLILIK KABILIYETLERININ INCELENMESI

Şerbetçioğlu Hıçkıran**,** Cemre

İşletme Doktora Programı

Tez Danışmanı: Prof. Dr. Bengü SEVIL OFLAÇ

Ocak, 2024

Küreselleşme ve teknolojik gelişmelerin ortaya çıkmasıyla birlikte, hızla değişen eğilimler ve artan talepler nedeniyle, moda endüstrisi üzerinde büyük bir baskı oluşmuştur. Bu durum, şirketleri her zamankinden daha fazla tedarik zinciri yönetimine odaklanmaya zorlamaktadır. Moda sektörünün volatilitesi nedeniyle arz ve talebi eşleştirmek zaten zorlu bir problemken, geçtiğimiz yıllarda küresel pazarda yaşanan dalgalanmalar tedarik zincirlerinde aksamalara sebep olmaktadır. Moda tedarik zincirleri üzerine bulunan mevcut literatürde, doğal ve insan kaynaklı afetler olmak üzere, finansal, etik ve çevresel risklerden bahsetmektedir. Bahsedilen tedarik zinciri düzensizlikleri başka tetikleyici etkilere sebep olarak domino etkisine yol açarak bütün tedarik zinciri ağını etkileyebilmektedir. Tedarik zinciri kabiliyetlerini operasyonel ve stratejik yapılarına entegre etmeleri tedarik zincirlerinin hayatta kalmasında büyük önem taşımaktadır. Son yaşanılan Korona virüs salgını nedeniyle de, bu tür aksamaları hafifletirken bir yandan da rekabet avantajı sağlamak adına elastik tedarik zinciri modeli giderek önem kazanmaktadır. Bu nedenle, bu çalışmanın

amacı Korona virüs salgını ve küresel ısınma benzeri ekstrem aksamaların global moda sektörü tedarik zinciri üzerine etkisini incelemek ve hangi direçli tedarik zinciri kabiliyetlerinin bu aksamalarda önem kazandığını ortaya çıkarmaktır. Bu bağlamda, ilk olarak sistematik bir literatür taraması yapılmış, ardından seçilmiş moda şirketleriyle yarı yapılandırılmış mülakatlar ve beraberinde haber içerik analizi gerçekleştirilmiştir. Niteliksel çalışmanın ardından, mülakatlardan elde edilen moda şirketleri ve tedarik zinciri yeteneklerini sınıflandırmak için bir matematiksel model geliştirilmiş ve böylece dayanıklılık stratejilerinin geliştirilmesine yönelik deneysel içgörüler sunulmuştur.

Anahtar Kelimeler: Dirençli tedarik zincirleri, moda sektörü, tedarik zinciri aksamaları

Dedicated to my daughter

ACKNOWLEDGMENTS

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LIST OF ABBREVIATIONS

SLR: Systematic Literature Review

DCV: Dynamic Capabilities View

RBV: Resource Based View

VRIN: Valuable, Rare, Inimitable, and Non-substitutable resources

ROT: Resource Orchestration Theory

CAS: Complex Adaptive Systems

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

LIHF: Low-Impact-High-Frequency

HILF: High-Impact-Low-Frequency

JIT: Just-in-time

QR: Quick Response

AR: Augmented Reality

VR: Virtual Reality

3D: Three Dimensional

AI: Artificial Intelligence

BDA: Big Data Analytics

CSC: Circular Supply Chains

WHO: The World Health Organization

SME: Small and Medium Enterprise

RSC: Reconfigurable Supply Chain

SKU: Stock Keeping Unit

IT: Information Technology

DeFi: Decentralized Finance

WCSS: Within-cluster Sum of Squares

ASRS: Automated Storage and Retrieval Systems

CHAPTER 1: INTRODUCTION

1.1. Introduction of the Main Concept and General Aims of the Study

For a long while, fashion has been known as a significant phenomenon that affects our lives in many ways. In today's highly competitive world, the fashion system has highly complex supply networks as one of the global industries (Macchion et al., 2015). According to Christopher, Lowson and Peck (2004), the uncertain and complex nature of today's fashion market has the following characteristics: short life cycles, high volatility, low predictability and high impulse purchases. Contemporary fashion is further characterized by its volatility, velocity, variety, complexity and dynamism (Čiarnienė and Vienazindiene, 2014), which led to an extension over the number of seasons and enlargement of the frequency of collections, lines and styles such as the extreme case of Zara with 20 seasons in a year (Lemieux et al., 2012). The constant need of companies to refresh the range of their products and the ever-shorter delivery times have prompted the importance of time as a competitive advantage. However, a significant problem in the fashion industry is the timing of sourcing the raw materials, converting them into final products and releasing them into the market. Hence, the complexity of the fashion industry, including the time factor, requires a responsive supply chain to bring the product into the market while satisfying consumer demand at its peak (Christopher, Lowson and Peck, 2004; Irfan, Wand and Akhtar, 2020; Khan, Christopher and Creazza, 2012).

With globalization and recent technological developments, as well as rapidly changing trends and growing demands, there has been great pressure on the fashion industry, forcing companies to focus on supply chain management more than ever (Iannone et al., 2013). While matching supply and demand is already a very challenging problem because of the market volatility in the fashion industry, with the disruptions that occurred in the global market over the past decade, both internally and externally, fashion retail companies encountered a series of difficulties that eventually led breakdowns in the supply chain (Ye and Lau, 2018).

In recent decades, global supply chains have been significantly disrupted by a range of unpredictable events. These include not only natural disasters like earthquakes (Taiwan in 2010), tsunamis (Indian Ocean in 2004), and hurricanes (US in 2005) but also widespread health crises such as pandemic diseases (SARS in 2003, bird flu in 2005, swine flu in 2009, and coronavirus in 2020). Alongside such disruptions, the

2008 financial crisis emerged as a major disruptor, severely impacting fashion supply chains by drastically reducing consumer spending and tightening credit markets.

Furthermore, geopolitical tensions and wars, particularly the US-China trade dispute that escalated in 2018, have led to the imposition of tariffs and trade barriers, significantly impacting the cost and availability of raw materials and finished goods in the fashion industry. Additionally, the recent Russia-Ukraine war has further complicated the global supply landscape. It has caused disruptions in logistics and supply routes, particularly in Eastern Europe, and led to increased energy prices and raw material costs.

In addition, the evolving regulatory landscapes, such as the stricter environmental and sustainability standards introduced by the European Union, have compelled fashion companies to re-evaluate their production processes and supply chain practices. These new regulations aim to address concerns like carbon emissions and waste management, forcing companies to invest in sustainable and eco-friendly solutions. Changes in labor laws, particularly in key manufacturing countries like Bangladesh and Vietnam, have also impacted the fashion supply chain. For instance, the implementation of higher minimum wages and stricter working conditions in these countries, following incidents like the Rana Plaza collapse in 2013, has influenced production costs and timelines.

Moreover, the industry's rapid digitization and the remarkable rise of e-commerce have significantly changed consumer behavior and expectations. The shift towards online shopping, accelerated by the COVID-19 pandemic, has resulted in demand for faster and more flexible supply chain solutions. Concurrently, the persistent and escalating issue of climate change continues to exert pressure on global supply chains. The greatest challenge of the century, 'climate change', necessitates the implementation of resilient supply chains to manage risks associated with higher temperatures and extreme weather events like heatwaves, droughts, and floods (Ghadge, Wurtmann and Seuring, 2020). With the increased wildfires and droughts across the globe in recent years, the environmental concerns regarding fashion supply chains have also increased; since raw materials such as cotton need a lot of water to grow, it also threatens the fashion industry.

Given the myriad of disruptions faced, it's crucial for fashion companies to prioritize building resilient supply chains, adapting proactively to navigate and overcome these complex global challenges effectively. Since the supply chain's

success depends on its capacity to adapt to such changes, building a resilient supply chain becomes more important than ever for mitigating such risks while having a competitive advantage (Abeysekara, Wang and Kuruppuarachchi, 2019; Hohenstein et al., 2015; Yao and Meurier, 2012). Therefore, this thesis aims to explore how disruptive events, particularly extreme conditions such as the recent COVID-19 global pandemic and climate change, have affected fashion supply chains while investigating the supply chain capabilities implemented by fashion companies to cope with such circumstances. Building on this foundation, this thesis further aims to classify these companies according to their developed supply chain capabilities for resilience against extreme disruptions, examining how they strategically combine different resilience capabilities in response to such challenges as the COVID-19 pandemic and climate change.

1.2. Significance of the study

The need for a resilient supply chain has anticipated researchers and managers such as natural disasters (Sáenz and Revilla, 2014; Yang and Xu, 2015), economic and financial crises (Jüttner and Maklan, 2011) and terrorism (Sheffi, 2001), and internally such as infrastructure issues and delivery disruptions (Carvalho, Azevedo, and Cruz-Machado, 2012; Ambulkar, Blackhurst, and Grawe, 2015; Chowdhury and Quaddus, 2017). However, approaches to cope with supply chain resilience strategies in extreme circumstances that disrupt supply chains along multiple dimensions, such as pandemics and climate change, remain scarce (Sodhi and Tang, 2021). This study may provide crucial capabilities for managing supply chain resilience in extreme disruptions.

Moreover, in the fashion context, to the best of our knowledge, there exists little research on resilience that addresses the natural and man-made disruptions in fashion supply chains (Christopher and Holweg, 2011; Martino et al., 2017). This study may provide pivotal insights into enhancing the resilience of fashion supply chains against such disruptions, thereby contributing significantly to both academic research and practical applications in the industry.

Last but not least, there exists little research on fashion supply chain resilience strategies developed in the quantitative domain (Abeysekara, Wang, and Kuruppuarachchi, 2019). In this thesis, a mathematical model is developed to cluster fashion companies and supply chain capabilities revealed from the interviews, thereby providing empirical insights into the development of resilience strategies. To the best

of our knowledge, this approach, largely unexplored in existing literature, aims to enhance the understanding of supply chain resilience in the fashion industry through a data-driven perspective.

1.3. Research Questions

The following research questions were developed to guide the thesis:

RQ1: *What are the major sources of disruption that fashion supply chains can encounter, and how do such disturbances affect fashion supply chains?*

RQ2: *Which capabilities are required to build resilience in such turbulent business environments?*

RQ3: *What are the barriers to designing resilient fashion supply chains?*

RQ4: *How can the selected companies be classified based on the supply chain capabilities they have built to become resilient?*

RQ5: *Which distinct resilience capabilities are strategically combined by fashion supply chain actors amidst disruptive events?*

1.4. Structure of thesis

This thesis is structured as follows. In Chapter 2, a systematic literature review (SLR) is adapted, followed by a descriptive and thematic analysis, which allows us to shed light on the current approaches in the supply chain resilience context while providing a summary overview of the selected articles. Supply chain disruptions, supply chain vulnerabilities and supply chain capabilities are reviewed in detail.

Subsequently, in Chapter 3, a semi-systematic review of fashion supply chain resilience is conducted to deepen the fashion-oriented knowledge. The same procedures mentioned previously for SLR have been applied to the review process, including a descriptive and thematic analysis.

After the analyses of the literature, in Chapter 4, the concept of fashion supply chain resilience is explored through the lens of Dynamic Capabilities View (DCV), Resource Orchestration Theory (ROT), and Complex Adaptive Systems (CAS). This theoretical framework provides a comprehensive understanding of how fashion supply chains adapt and evolve in response to various disruptions.

Chapter 5 includes the methodological approaches used in this thesis. Research design is explained first, followed by the details of semi-structured interviews, such as the sample characteristics, and news content analysis, such as secondary data

examples.

In Chapter 6, findings of the semi-structured interviews and the news content analysis are provided. Chapter 7 presents the quantitative study where a mathematical model is built to cluster the informant companies and their resilience capabilities.

Finally, a discussion of the findings and their contribution to theory and practice is addressed in Chapter 8. Additionally, the limitations of the study are explained, and recommendations for further research are provided.

CHAPTER 2: SUPPLY CHAIN RESILIENCE

2.1. Systematic Literature Review Approach

In this thesis, first, a review based on techniques adapted from the Systematic Literature Review is chosen in the supply chain resilience context, then narrowed down to the scope of fashion supply chain resilience. Selecting the supply chain resilience context as a starting point for the systematic literature review was a crucial process of the study since it lays the basis for comprehensive research on supply chain resilience in the fashion context. Moreover, such an approach provides a thorough understanding of the existing body of work and helps identify the gaps to explore in the relevant topic (Xiao and Watson, 2017). Unlike traditional reviews, a systematic literature review has a set of protocols that prevents bias against the selection of the articles while providing validity, transparency and reliability of the findings (Tranfield, Denyer, and Smart, 2003; Thomé, Scavarda, and Scavarda, 2016). Using frameworks developed by Fisch and Block (2018), Petticrew and Roberts (2008) and, Tranfield, Denyer, and Smart (2003) and the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), a systematic literature review on supply chain resilience was conducted first.

Both reviews comprise of the steps of (1) identification of relevant research, (2) checking eligibility, (3) screening of articles and (4) inclusion of articles which are provided by PRISMA. For greater quality of the search results, inclusion and exclusion criteria are integrated following the guidelines of Newbert (2007):

(1) Articles published in peer-reviewed scientific journals in English,
(2) The most relevant journals in the business management discipline, particularly in the area of logistics, operations management and supply chain management in particular,
(3) Empirical research articles, qualitative or quantitative, including theoretical articles
(4) Articles published in the last 20 years.

The year 2003 was selected as the initial point of the search since Rice and Caniato's article is the first study that mentions supply chain resilience and is considered as the foundation of the term, which is followed by Christopher and Peck's

2004 and Sheffi and Rice's 2005 articles. Since then, their work on supply chain resilience has been a motivation to researchers in the field. Considering the fact that it plays an important role in screening and analyzing the data, in line with previous systematic literature reviews on supply chain resilience (Ali, Mahfouz, and Arisha, 2017; Hohenstein et al., 2015; Pereira et al., 2014), the most relevant keyword strings were selected which are 'supply chain' and 'resilien*'. Using these search strings on electronic databases, Web of Science and Scopus, a total of 2143 articles were identified. Following the PRISMA guideline, duplicate articles were removed first. Then, the remaining 1477 articles were screened, and 982 were removed via title and abstract screening since they did not meet the inclusion criteria (Newbert, 2007). Following, the introduction and conclusion sections were reviewed among the remaining 495 articles in the second selection and 129 articles were removed, resulting in a total of 366 candidate articles. A further 24 articles were identified through cross-referencing citations, leading to a literature sample of 389 eligible journal articles. In total, a literature sample consisting of 390 journal articles was fully read, and 55 of them were excluded since they did not provide related information regarding the purposes of this thesis. Finally, 335 articles on supply chain resilience were considered as eligible as a result of this process. The remaining 335 articles were analyzed in order to capture the dearth of knowledge on supply chain resilience and to further support the research questions addressed. A graphical representation of the selection and evaluation process is illustrated within the flow chart diagram of PRISMA in Figure 1. In the following subsections, the current state of studies on supply chain resilience and fashion supply chain resilience are discussed, respectively.
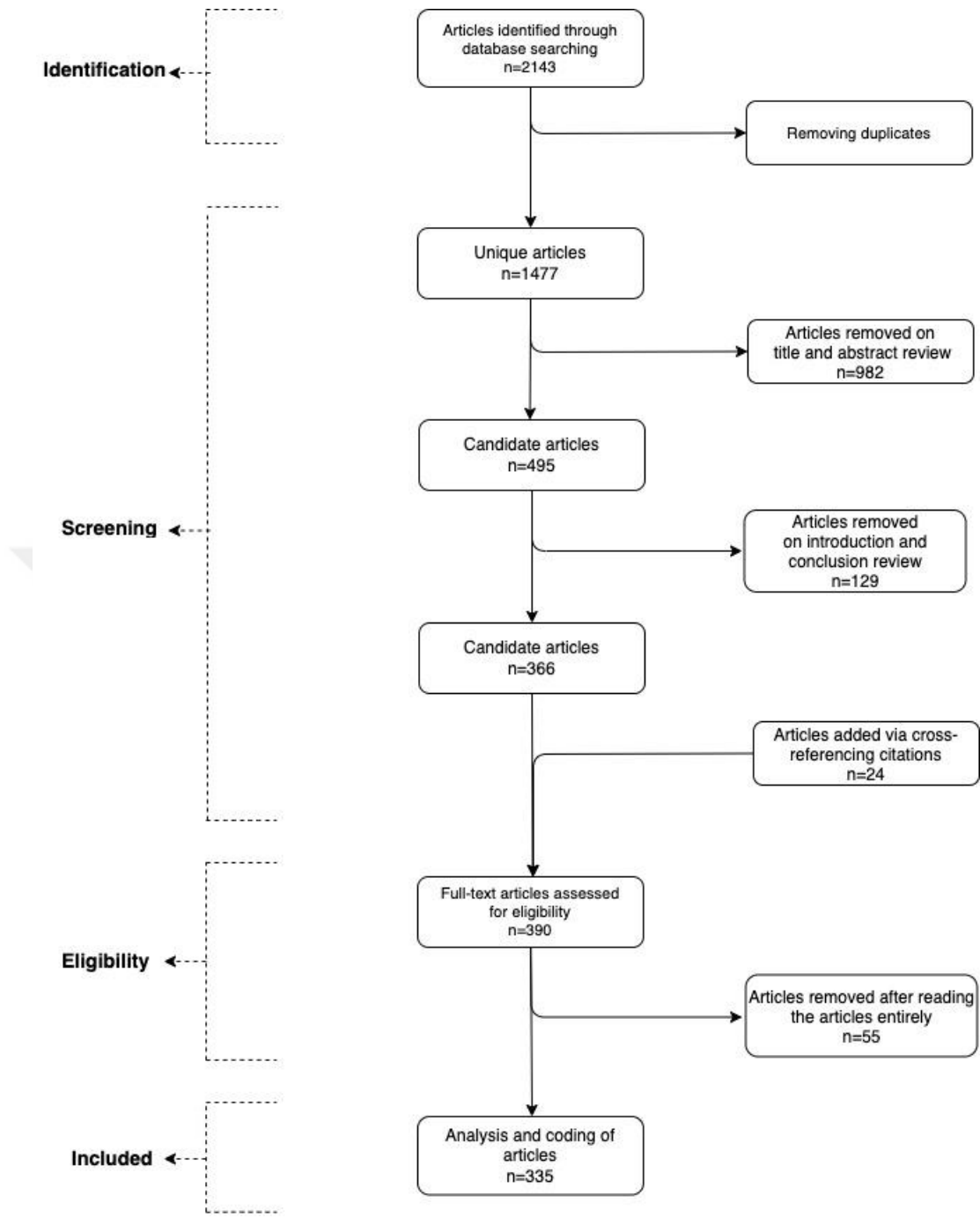
Figure 1. Review Process for Study Selection in Supply Chain Resilience

2.2. Descriptive Analysis

Following the article selection, the content of the 335 articles included in the study was analyzed to provide an overall map of the articles dealing with supply chain resilience. The publication year, academic journal, methodological approaches, applied theories and focused supply chain resilience antecedents of the articles selected from 2003 to 2023 were reviewed and further discussed in detail in the following subsections. For this purpose, a descriptive analysis is conducted to review the development and current situation of the supply chain resilience literature, considering five viewpoints:

1. distribution of articles over the years,
2. distribution of articles across journals,
3. distribution of articles by methodology,
4. distribution of articles by theory
5. distribution of articles by supply chain resilience capabilities (e.g., flexibility, collaboration, agility, etc.)

Figure 2 shows the number of publications per year where the growth in the number of articles published over the last year is significant, reflecting the outcomes of the recent COVID-19 pandemic outbreak. Furthermore, since the articles from the first half of 2023 were included in this thesis, the number of articles for the year 2023 in the figure appears to be low in comparison to the increase in previous years. Consistent with the existing studies in the field, the increasing number of publications on supply chain resilience through the years also indicates the fact that supply chain resilience is a trending research agenda. However, compared to supply chain management, publications in the field of supply chain resilience remain scarce (Blackhurst, Dunn, and Craighead, 2011; Hohenstein et al., 2015; Pereira et al., 2014; Ponomarov and Holcomb, 2009).
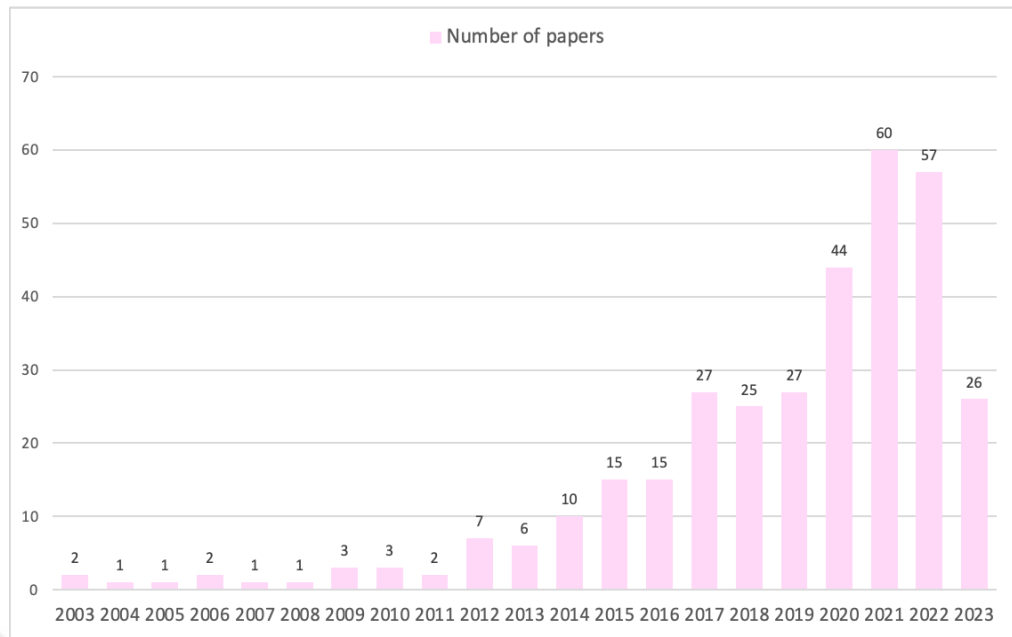
Figure 2. Year-wise Distribution of Publications

In addition, the journal-wise distribution of the articles (Table 1) showed that the majority of the contributions were published in the *International Journal of Production Research* (24), *International Journal of Production Economics* (22) and *International Journal of Logistics Management* (15). Moreover, the published journals cover a variety of research areas, such as operations management, supply chain management, logistics, and production research. This diversity of the journal research areas also emphasizes the interdisciplinary nature of the topic of supply chain resilience (Bier, Lange, and Glock, 2020).

Table 1. Distribution of Articles Across Journals

Journal	Number of papers
International Journal of Production Research	24
International Journal of Production Economics	22
International Journal of Logistics Management	15
Supply Chain Management	13
Benchmarking: An International Journal	12
Sustainability	12
Computers & Industrial Engineering	11
Supply Chain Management: An International Journal	11
Transportation Research Part E: Logistics and Transportation Review	11
International Journal of Logistics Research and Applications	10
Annals of Operations Research	9

Table 2. (cont'd) Distribution of Articles Across Journals

Journal	Count
International Journal of Operations and Production Management	9
International Journal of Physical Distribution and Logistics Management	9
International Journal of Supply Chain Management	9
Journal of Business Logistics	9
Production Planning & Control	7
Omega	6
Operations Management Research	6
Journal of Enterprise Information Management	5
The International Journal of Logistics Management	5
International Journal of Disaster Resilience in the Built Environment	4
Journal of Purchasing and Supply Management	4
Sustainable Production and Consumption	4
Environmental Science and Technology	3
Frontiers of Engineering Management	3
International Journal of Agile Systems and Management	3
International Journal of Integrated Supply Management	3
International Journal of Logistics Systems and Management	3
Journal of Operations Management	3
Logistics Research	3
Operations and Supply Chain Management: An International Journal	3
Supply Chain Forum	3
Technological Forecasting and Social Change	3
European Journal of Operational Research	2
Global Business Review	2
International Journal of Services and Operations Management	2
Journal of Business & Industrial Marketing	2
Journal of Cleaner Production	2
Journal of Global Operations and Strategic Sourcing	2
Journal of Manufacturing Technology Management	2
Journal of Operations and Supply Chain Management	2
Journal of Risk Research	2
MIT Sloan Management Review	2
Technology in Society	2
Africa Journal of Management	1
Asia Pacific Journal of Marketing and Logistics	1
Asia Pacific Management Review	1
Asia Pacific Journal of Business Administration	1
British Journal of Management	1
Business Horizons	1
Business Process Management Journal	1
Business Strategy and the Environment	1
Decision Science	1

Table 3. (cont'd) Distribution of Articles Across Journals

Electronic Commerce Research and Applications	1
Environment Systems and Decisions	1
Expert Systems with Applications	1
Industrial Management and Data Systems	1
Industrial Marketing Management	1
Information Technology & People	1
International Journal of Business Performance Management	1
International Journal of Data and Network Science	1
International Journal of Disaster Risk Reduction	1
International Journal of Emergency Services	1
International Journal of Information Systems and Supply Chain Management	1
International Journal of Lean Six Sigma	1
International Journal of Management Science and Engineering Management	1
International Journal of Procurement Management	1
International Journal of Productivity and Performance Management	1
International Journal of Quality & Reliability Management	1
International Journal of Supply and Operations Management	1
International Journal of Systems Science: Operations and Logistics	1
International Transactions in Operational Research	1
Journal of Advances in Management Research	1
Journal of Applied Business Research	1
Journal of Business Research	1
Journal of Humanitarian Logistics and Supply Chain Management	1
Journal of Industrial Engineering International	1
Journal of Knowledge Management	1
Journal of Management Science and Engineering	1
Journal of Modelling in Management	1
Journal of Regional Science	1
Journal of Risk and Financial Management	1
Journal of Strategic Marketing	1
Journal of Supply Chain Management	1
Journal of the Knowledge Economy	1
Journal of Transport and Supply Chain Management	1
Management and Production Engineering Review	1
Management Decision	1
Management Research Review	1
Modern Supply Chain Research and Applications	1
Production & Manufacturing Research	1
Production and Operations Management	1
Retail and Marketing Review	1
Risk Analysis	1
Simulation Modelling Practice and Theory	1

Table 4. (cont'd) Distribution of Articles Across Journals

Supply Chain Management Review	1
Technology Analysis and Strategic Management	1
Total Quality Management & Business Excellence	1
Transportation Research Part A: Policy and Practice	1
Transportation Research Part B: Methodological	1
TOTAL	**335**

As shown in Figure 3, several methodologies have been used in the literature to address the topic of supply chain resilience. The analysis indicated that surveys, case studies, and modeling were often used across the 335 selected articles on the supply chain resilience context. Interviews were found to be the most popular form of primary data collection among the empirical articles. Another finding from the analysis is that quantitative research on supply chain resilience in pandemic and epidemic diseases, such as the recent COVID-19 pandemic outbreak, remains scarce (Queiroz et al., 2022).
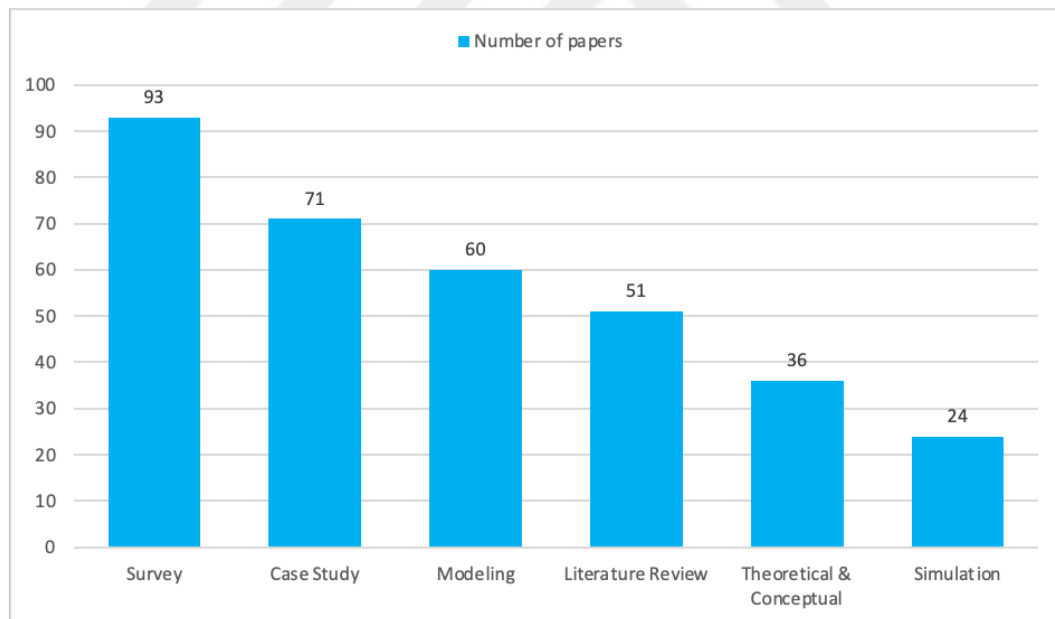
Figure 3. Distribution of Methodologies

Regarding the empirical theories adopted in the literature, various theories have been used to address the topic of supply chain resilience. Table 2 demonstrates that Dynamic Capabilities (Chowdhury and Quaddus, 2017; Golgeci and Ponomarov, 2013; Ponomarov and Holcomb, 2009) and Resource Based View (Blackhurst, Dunn

and Craighead, 2011; Brandon-Jones et al., 2014; Ponomarov and Holcomb, 2009) are by far the most commonly employed theories in the field. Although there exists an increase in the number of theories used in supply chain resilience research, according to Ali, Mahfouz, and Arisha (2017), there still exists a lack of theory grounding in the supply chain resilience context, which eventually restricts defining supply chain resilience from a theoretical perspective.

Table 5. Distribution of Theories

Theory	Number of papers
Dynamic Capabiliities View	43
Resource Based View	25
Social Capital	11
Complex Adaptive Systems	8
Fuzzy Set Theory	8
Information Processing Theory	7
Contingency Theory	6
Graph Theory	5
Grey Theory	5
Systems Theory	5
Organisational Information Processing Theory	4
Complexity Theory	3
Contingent Resource-Based View	2
High Reliability Theory	2
Network Theory	2
Relational View	2
Resource Dependence theory	2
Resource Orchestration Theory	2
Social Exchange Theory	2
Absorptive Capacity Theory	1
Capital Based View	1
Competing Values Framework	1
Dependency Theory	1
Dynamic Managerial Capabilities Theory	1
Dynamic Systems Theory	1
Fitness Landscape Theory	1
Game Theory	1
Institutional Pressure theory	1
Institutional Theory	1
Item Approach	1
Knowledge-based view	1
Multilevel Theory	1

Table 6. (cont') Distribution of Theories

Normal Accident Theory	1
Organizational Culture Theory	1
Panarchy Theory	1
Quality Function Deployment	1
Resilience Theory	1
Social Network Theory	1
Stakeholder Theory	1
Stakeholders' Resource-Based View	1
Statistical Information Theory	1
Strategic Choice Theory	1
Theory of Bayesian Network	1
Theory of Diversity	1
Theory of Organizational Readiness for Change	1

2.3. Supply Chain Resilience Concept and Its Definitions

In recent decades, catastrophic events diverted the attention of both researchers and practitioners towards resilience, showing that not all risks can be avoided. Global supply chains have been disrupted by a number of unpredictable events such as terrorist attacks (9/11 in 2001), earthquakes (Taiwan in 2010, Japan in 2011), tsunamis (Indian Ocean in 2004), hurricanes (US in 2005), wildfires (Australia in 2019) and pandemic diseases (SARS in 2003, bird flu in 2005, swine flu in 2009 and COVID-19 in 2020). While such disruptive events can be considered major threats to human lives affecting all areas of society, in the meantime, they also test supply chains by the long-term impacts and high uncertainty risks (Sarkis, 2020).

Due to the interconnection among supply chain members, the magnitude and scope of such disruptive events tragically showed that the actions of downstream and upstream actors of complex networks profoundly affected the other. Hence, the need for mitigating such risks while not restricting them to organizational boundaries, such as implementing capabilities for both themselves and their supply chain partners, is crucial to rapidly react and recover to a pre-disruptive state or even a better one (Ali, Mahfouz, and Arisha, 2017; Chowdhury and Quaddus, 2017).

Resilience in the supply chain management field has been described and is still being described by various researchers through the years, which are chronologically listed in Table 3. Despite the growing research, there is still no consensus on the supply chain resilience definition (Adobor, 2019; Sahu, Datta, and Mahapatra, 2017;

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Spiegler, Naim, and Wikner, 2012; Tukamuhabwa et al., 2015). On the other hand, Kaviani et al. (2020) argued the fact that there is no need to develop a universal description since resilience depends on such situations that are unique to themselves. More recently, Wieland and Durach (2021) argued that supply chain resilience needs to move beyond engineering resilience and incorporate social-ecological resilience. Consistent with the previous train of thought, in this thesis, we also define supply chain resilience as *"the ability to maintain, adapt and recover from any unexpected disturbances to its pre-disruption state or even more desirable one"*.

Table 7. Definition of Supply Chain Resilience Through Years

Authors	Definition of Supply Chain Resilience
Christopher and Peck (2004, p. 2)	*"The ability of a system to return to its original state or move to a new, more desirable state after being disturbed"*
Sheffi and Rice (2005, p. 41)	*"The ability to bounce back from a disruption"*
Datta et al. (2007, p. 189)	*"... not only the ability to maintain control over performance variability in the face of disturbance but also a property of being adaptive and capable of sustained response to sudden and significant shifts in the environment in the form of uncertain demands"*
Ponomarov and Holcomb (2009, p. 131)	*"The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function"*
Zsidisin and Wagner (2010, p. 3)	*"... the ability to return to normal performance levels following a supply chain disruption."*
Jüttner and Maklan (2011, p. 247)	*"... the supply chain's ability to cope with the consequences of unavoidable risk events in order to return to its original operations or move to a new, more desirable state after being disturbed"*
Ponis and Koronis (2012, p. 925)	*"The ability to proactively plan and design the supply chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operations, if possible, more favourable than the one prior to the event, thus gaining competitive advantage"*
Pettit et al. (2013, p. 46)	*"... the ability to survive, adapt, and grow in the face of turbulent change"*
Pereira et al. (2014, p. 627)	*"... the capability of supply chains to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one"*
Ambulkar et al. (2015, p. 112)	*"... the capability of the firm to be alert to, adapt to and quickly respond to changes brought by a supply chain disruption"*

Table 8. (cont'd) Definition of Supply Chain Resilience Through Years

Kamalahmadi and Mellat-Parast (2016, p.121)	*"The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations"*
(Brusset and Teller, 2017)	*"... is an operational capability that enables a disrupted or broken supply chain to reconstruct itself and be stronger than before"*
Pires Ribeiro and Barbosa-Povoa, (2018, p.116)	*"A resilient supply chain should be able to prepare, respond and recover from disturbances and afterwards maintain a positive steady state operation in an acceptable cost and time."*
Hosseini et al., 2019, p.292	*"SC capability to utilize the absorptive capacity of SC entities to repulse and withstand the impacts of perturbations, to minimize the consequences of disruptions and their propagation by utilizing adaptive capacity and to recover performance level to normal operations in a cost-efficient manner using restorative capacity when absorptive and adaptive capacities are not sufficient."*
Novak et al., 2020, p.10	*"A supply chain is resilient to the extent that the system can maintain core functionality by continually adapting, evolving, and transforming in response to the dynamic multiscale feedbacks that occur between the multitude of interconnected organizations, institutions, and social and ecological systems that are all parts of the larger supply chain."*
Wieland and Durach, 2021, p.2	*"... the capacity of a supply chain to persist, adapt, or transform in the face of change. "*

The extant research on resilience showed that resilient firms are relatively more prepared for such disruptions compared to their competitors who are not prepared for such events (Ambulkar, Blackhurst, and Grawe, 2015; Sá et al., 2019; Ponomarov and Holcomb, 2009). In this regard, considering the scope of the interconnections at the global level and the dynamic nature of the supply chains, the need for building a resilient supply chain has attracted attention from researchers and managers for a while, both externally, such as natural disasters (Sáenz and Revilla, 2014; Yang and Xu, 2015), economic and financial crisis (Jüttner and Maklan, 2011), and terrorism (Sheffi, 2001), and internally such as infrastructure issues and delivery disruptions (Ambulkar, Blackhurst, and Grawe, 2015; Carvalho, Azevedo, and Cruz-Machado, 2012; Chowdhury and Quaddus, 2017).

2.3.1. Supply Chain Disruptions

Supply chain disruptions are unplanned and unanticipated events that stop or impede the normal flow of goods and materials within a supply chain (Craighead et al., 2007; Kleindorfer and Saad, 2005; Stauffer, 2003; Svensson, 2000; Wagner and Bode, 2008). There are several classifications of disruptions in the literature while studying disruptive events is generally classified into two sources: external, such as natural disasters, terrorist attacks, etc. and internal, such as a failure of any function in a supply chain or human error (Ponomarov and Holcomb, 2009). Sheffi (2015) more specifically characterizes the scale of impact of such events as localized disruptions (natural disasters, industrial accidents, terrorist strikes) and global crises (pandemic diseases) where multiple countries and industries are affected at the same time. While disruption classifications of the previous studies showed that the categorization generally focused on how a disruptive event might occur or how it might impact the supply chain, but from a different perspective, DuHadway, Carnovale, and Hazen (2019) distinguished disruptions as exogenous/endogenous disruptions and intentional/inadvertent disruptions where they further conceptualized events in for subcategories as performance failures, force majeure, inside job and disruptive strikes.

In order to avoid or mitigate supply chain disruptions, extant literature heavily focused on the risk sources that a disruption may arise. Kleindorfer and Saad (2005) suggested two categories of risks that are operational and long-term, which are also introduced as low-impact high-frequency (LIHF) and high-impact low-frequency (HILF) risks, respectively. While operational risks manifest in various ways, such as supply-demand disparity, lead time uncertainties, machine breakdowns, etc., long-term risks are the ones that are external to the network, such as natural hazards, terrorism, and political instabilities that have longer recovery periods.

Table 4 shows that within the literature, supply chain risks are generally categorized into two: disruption risks that are unforeseeable, such as natural and man-made disasters (Parast and Shekarian, 2019) and operational risks that are mainly concerned with supply-demand errors due to failed coordination (Nooraie and Parast, 2015; Yang, Pan, and Ballot, 2017) which makes operational risks relatively more manageable. Christopher and Peck (2004) further expanded this classification into three: internal, such as infrastructure failures; external to the firm; internal to the supply chain, such as demand or supply-related risks; and external, such as environmental disruptions. There are also various categorizations of supply chain risks

in the literature, such as Ho et al.'s (2015) macro and micro risk perspective. Macro-risks refer to external or natural risks, whereas micro-risks consist of internal risks such as recurrent events. Micro-risks are further divided into four subcategories: demand risk, manufacturing risk, supply risk and infrastructural risk.

Table 9. Classification of Supply Chain Risks

Supply Chain Risks		
Disruption Risks	Operational Risks	
External Risks	External to the firm but Internal to the supply chain	Internal to the firm
Natural Disasters	*Supply Risks*	*Process Risks*
Earthquakes, droughts, floods, storms, cyclones, volcanic eruptions, etc.	Quality issues, variability of replenishment lead time, capacity fluctuations, supplier bankruptcy, etc.	Bottlenecks, product quality issues, machine failure, IT infrastructure failure, labor strikes etc.
Man-made Disasters	*Demand Risks*	*Control Risks*
Terrorism, economic downturn, technology changes, political instability, war	Demand volatility, market changes, forecast errors, competitor's moves, etc.	Poor visibility through supply chain, safety stock policy, order quantity and batch size policy, lack of collaborative forecasting, bullwhip effects

Whether it is natural or human-made, disruptions are an intrinsic part of supply chains, and since the supply chain's success depends on its capacity to adapt to such changes, building a resilient supply chain becomes more important than ever for mitigating such risks (Abeysekara, Wang, and Kuruppuarachchi, 2019; Hohenstein et al., 2015; Yao and Meurier, 2012). Effective supply chain risk management is crucial to mitigate the effects of such disruptive events, and in some cases, even a redesign of the supply chain may be required considering the scale of the disruption (Cantor et al., 2014; Chopra and Sodhi, 2004; Sodhi and Tang, 2012). Nonetheless, not all disruptive events happen at the same speed. For instance, the 9.0 magnitude earthquake in Japan, which is considered as one of the largest disruptions to global supply chains, not only affected local businesses but also caused damage to various industries across the global supply chain because of the shortage of parts supplied from Japan (Lohr, 2011). While sudden-onset disasters such as earthquakes and tsunamis unfold almost instantly creating physical impacts, slow-onset disasters can be predicted much further in advance and unfold over a longer period of time creating social and economic impacts such as famine and drought. Table 5 demonstrates classifications of

disasters in terms of their speed (Van Wassenhove, 2006).

Table 10. Types of Disasters

Origin/Speed	Slow-onset	Sudden-onset
Natural Disasters	climate change, famine, drought, deforestation, poverty,	earthquakes, tsunamis, cyclones/storms/hurricanes/typhoons, volcanic eruptions, floods, tornadoes, landslides, wildfires
Man-made Disasters	political crisis, refugee crisis, economic crisis, environmental pollution	terrorism, Coup d'Etat, chemical leaks

Epidemics and pandemics are considered as unique disruptions that cause systematic threats to the supply chains, both internally and externally (Golan, Jernegan, and Linkov 2020). Although COVID-19 is not the first disaster that has led to disruptions in supply chains, compared to other infectious diseases where the businesses recovered in a matter of weeks, even during the early stages of the COVID-19 pandemic, its impact on global supply chains was massive (Govindan, Mina, and Alavi, 2020; Ivanov, 2020; Xu et al., 2020). According to Sodhi and Tang (2021, p.7),

"The additional challenges presented by COVID-19 in 2020 are extreme in being distinct from supply chain risk in that not just particular companies, but also entire societies are affected."

In their study, they demonstrate the need for extreme supply chain management for extreme circumstances such as pandemics, geopolitics, war, climate change or biodiversity collapse that simultaneously disrupt supply chains in multiple dimensions. Under such vulnerable situations, a resilient supply chain requires an ability to respond to those challenges, where supply chain capabilities play an instrumental role in mitigating risks (Hohenstein et al., 2015). Therefore, it is also important for a company to investigate vulnerabilities and capabilities of the entire network, including all actors, to improve supply chain resilience (Christopher and Peck, 2004).

2.3.2. Supply Chain Vulnerabilities

According to Colicchia and Strozzi (2012), supply chain risks are highly related to a supply chain's vulnerabilities since companies become more vulnerable as supply chains face disruptive events. Vulnerability was first introduced to the supply

chain context by Svensson's (2000) study, where he defined supply chain vulnerability as the

> *"existence of random disturbances that lead to deviations in the supply chain of components and materials from normal, expected or planned schedules or activities, all of which cause negative effects or consequences for the involved manufacturer and its sub-contractors" (p.732).*

In another definition by Christopher and Peck (2004), supply chain vulnerability is considered as an exposure to a disturbance. Since most companies realize their vulnerabilities only when a disruption occurs in their supply chain (Bier et al., 2020), understanding supply chain vulnerabilities is crucial in improving supply chain resilience (Fiksel and Fiksel, 2015). In order to mitigate disruption risks in a supply chain, Kleindorfer and Saad (2005) develop a conceptual framework where they identify sources of risks and vulnerabilities of a supply chain. They have categorized the supply chain vulnerability sources into three categories: operational factors, natural hazards and terrorism or political instability, whereas Blos et al. (2009) further categorized vulnerabilities into four categories; financial vulnerability, strategic vulnerability, hazard vulnerability and operations vulnerability.

Previous studies addressed various drivers of supply chain vulnerabilities such as customer dependency (Svensson, 2004), supplier dependency (Jüttner, 2005; Svensson, 2004), single sourcing (Zsidisin et al., 2004), and global sourcing (Jüttner, 2005). As a pioneer in the supply chain vulnerability context, Svensson further contributed to the field by distinguishing the types of vulnerability into two: atomic vulnerability, which concerns a part of the supply chain and holistic vulnerability (Svensson, 2004). In their study, Pettit, Fiksel, and Croxton (2010) discussed that supply chain resilience has two dimensions: vulnerabilities and capabilities. They presented supply chain vulnerabilities within three main categories: external vulnerabilities, such as financial or bureaucratic issues; internal vulnerabilities, like supplier and customer disruptions; and structural vulnerabilities, such as the supply chain design. On the other hand, in Chowdhury and Quaddus's (2015) study, where they developed a multi-objective optimization model, they gathered supply chain vulnerability factors that were previously addressed in the field under seven categories: hazard vulnerability, strategic vulnerability, financial

vulnerability, operational vulnerability, infrastructure vulnerability, demand and supply vulnerability. Pettit, Croxton, and Fiksel (2013) further developed a framework of balanced resilience where they discussed that the level of resilience in a supply chain can be measured via the balance between vulnerabilities and capabilities.

2.3.3. Supply Chain Capabilities

Supply chain capabilities are essential attributes for improving resilient supply chains, which eventually lead to improved business performance (Christopher and Peck, 2004; Jüttner and Maklan, 2011; Liao and Kuo, 2014; Pettit, Fiksel, and Croxton, 2010; Ponomarov and Holcomb, 2009; Sheffi and Rice, 2005). The extant literature suggested that effective implementation of supply chain capabilities leads to reducing vulnerabilities and being prepared for disruptions (Craighead et al., 2007). There exists a vast range of supply chain capabilities considered by both academicians and practitioners to develop a resilient mechanism, such as agility, responsiveness, reengineering, velocity, visibility, flexibility, redundancy, collaboration, transparency, robustness, etc. (Pettit, Croxton, and Fiksel, 2013). Although a wide range of capabilities has been discussed in the domain of supply chain resilience, most scholarly attention has been built on flexibility, as shown in Figure 4. Following flexibility, other capabilities such as visibility, collaboration, agility, and velocity also show a notable presence in the literature, indicating their recognized importance in building resilient supply chains. It is also observed that the following capabilities, which are mentioned less frequently, have been discussed in articles after 2020: Safety and Health, Supply Chain Alertness, Supply Chain Intelligence, Supply Chain Learning Orientation, Supply Chain Mapping, and Warning. Although not as prevalent in the research, these capabilities signify emerging areas of interest that reflect recent developments and shifting focuses within the domain. Additionally, the systematic review revealed an increasing focus on digital transformation capabilities in supply chain resilience literature. This trend aligns with the broader stimulus across industries towards digitalization, which has likely been accelerated by the global events of the past few years.
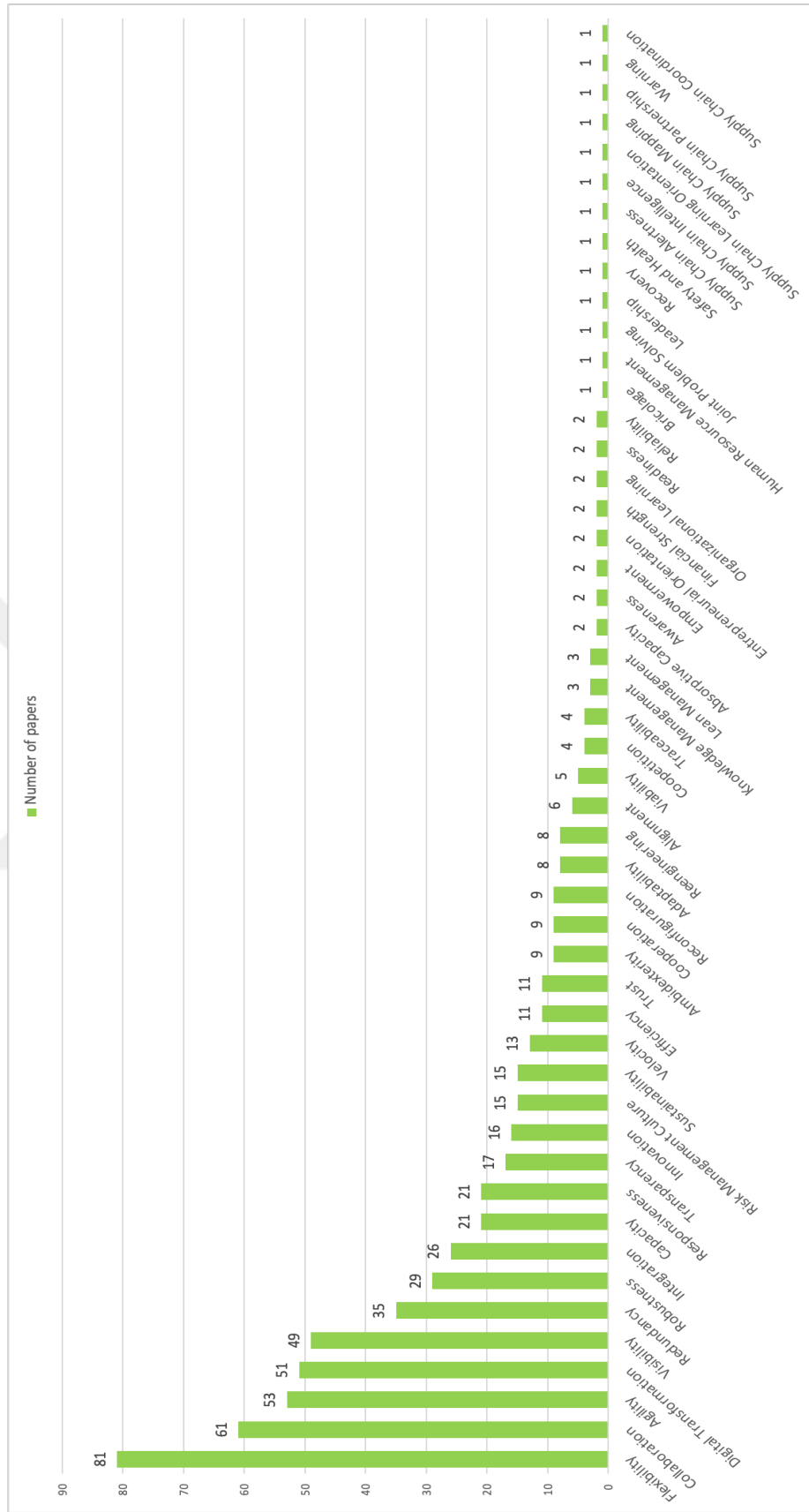
Figure 4. Distribution of Supply Chain Resilience Capabilities

In their study, Ali, Mahfouz, and Arisha (2017) developed a conceptual mapping framework where they distinguished supply chain capabilities according to the phases of disruptions. Supply chain resilience elements were gathered under the categories of ability to anticipate, ability to adapt, ability to respond, ability to recover and ability to learn. As shown in the figure above, key components in building resilient supply chains that were discussed by the researchers in the field are flexibility, collaboration, agility and visibility, which is also consistent with previous findings (Ali, Mahfouz, and Arisha, 2017). A vast number of researchers have investigated that supply chain flexibility is a key to mitigating any major disruption (Agarwal, Shankar, and Tiwari, 2006; Das, 2011; Gong, 2008; Stevenson and Spring, 2007) which is defined as the ability to respond and adapt to unforeseen changes (Sheffi and Rice, 2005). In some studies, flexibility is also assumed to be a dimension of agility (Chopra and Sodhi, 2004; Ponis and Koronis, 2012). Wieland and Wallenburg (2013, p.302) defined agility as

"the ability of a supply chain to rapidly respond to change by adapting its initial stable configuration".

In their study, they investigate the relationship between supply chain capabilities, particularly agility and robustness, and supply chain customer value, where they consider robustness as a supply chain's resistance or anticipation to change.

In terms of supply chain capabilities, many studies pointed out different recommendations for building resilience; for instance, Fiksel and Fiksel (2015) focused on visibility, that is, traceability of services from raw material to the end customer, whereas Christopher and Peck (2004) and Jüttner and Maklan (2011) considered velocity and visibility as an antecedent for agility. Existing studies have pointed out various capabilities that companies can adopt as resilience strategies, which enable a supply chain to bounce back from adverse events and adapt to uncertain future disruptions. All these strategic capabilities that comprise a resilient supply chain eventually provide an improved performance, allowing firms to be more sustainable. (Christopher and Peck, 2004; Jüttner and Maklan, 2011; Pettit, Fiksel, Croxton, 2010; Sheffi and Rice, 2005).

In light of the vulnerabilities exposed by COVID-19, numerous studies have

suggested strategies for minimizing impacts, recovering, and preparing for future pandemics. These strategies are categorized into three main dimensions of supply chain resilience: preparedness, response, and recovery, following the framework by Chowdhury and Quaddus (2016) and Ponomarov and Holcomb (2009). To address the pandemic-related shortages in essential goods, studies have recommended increasing production capacity, optimizing timing for building up production, reallocating resources, and employing temporary staff (Leite, Lindsay and Kumar, 2020; Mehrotra et al., 2020; Paul and Chowdhury, 2021; Veselovská, 2020),. Others suggest expanding manufacturing facilities (Shokrani et al., 2020) and adapting product features to meet demand with existing resources (Paul and Chowdhury, 2020).

The challenges of raw material shortages were highlighted by the case of an Australian hand sanitizer company that had to halt production (Paul and Chowdhury, 2021). Studies proposed strategies for upstream resilience, such as improving visibility in supply networks (Ivanov and Dolgui, 2020) and diversifying suppliers (van Hoek, 2020). Additionally, research suggests reconfiguring logistics and supply chains by suggesting nearshoring or backshoring production facilities (Cappelli and Cini, 2020; Deaton and Deaton, 2020; van Hoek, 2020), improving IT capabilities (Ibn-Mohammed et al., 2021; van Hoek, 2020), and automation to reduce dependency on human labor (Ivanov and Das, 2020). Easing capital flow has also been recommended to address capital shortages (Deaton and Deaton, 2020).

Partnerships are also essential for smoothing product and service flow (Veselovská, 2020), as well as improving information sharing and collaboration (Jabbour et al., 2020;). Strategies for dealing with reduced demand include price adjustments (Chiaramonti and Maniatis, 2020) and sustainability practices are advocated for resilience (Rizou et al., 2020). Researchers stress the importance of holistic, resilient response plans integrating multiple strategies for a viable supply chain that is agile, resilient, and sustainable in the post-COVID era (Baveja, Kapoor, and Melamed, 2020; Ivanov, 2020; Jabbour et al., 2020; Leite et al., 2020).

2.3.4. Supply Chain Resilience Strategies

Severe disruptions in a supply chain, such as unique ones like epidemics and pandemics, eventually lead to simultaneous disruption propagation that is experienced by the entire supply chain (i.e., ripple or domino effect) (Dolgui, Ivanov and Rozhkov, 2020; Queiroz et al., 2020). The domino or ripple effect may occur when a disruption leads to high and long-term impacts on downstream or

upstream levels while testing the dynamics of the supply chain. Hence, to manage such triggered events throughout the interconnected nodes in a supply chain, various strategies and actions are required to respond and adapt to the changing environment (Chen, Das, and Ivanov, 2019; Dolgui, Ivanov, and Rozhkov, 2020; Ivanov and Sokolov 2019; Pournader, Kach, and Talluri, 2020). Christopher and Peck (2004) conceptualized four main principles of supply chain resilience: reengineering, agility, collaboration and supply chain risk management. In this regard, a supply chain's orientation and culture of such concepts as supply chain risk management also play a crucial role in building a resilient supply chain (Chowdhury and Quaddus, 2017). According to Hohenstein et al. (2015), risk management comprises of four phases: (1) risk identification, (2) response, (3) recovery and (4) growth, whereas Blackhurst, Dunn and Craighead (2011), in their study with multiple industries, argued disruption across three stages (1) disruption discovery, (2) disruption recovery and (3) supply chain re-design.

Extant studies on supply chain resilience classified the strategies that should be adapted to prepare and recover from disruptive events into three categories: proactive, concurrent and reactive. (Ali, Mahfouz, and Arisha, 2017; Sheffi and Rice, 2005). Proactive strategies take place in the pre-disruption phase as a preparation (Ambulkar, Blackhurst, and Grawe, 2015; Day, 2014; Ponomarov and Holcomb, 2009), whereas reactive strategies are the ones required after the post-disruption phase as recovery from the disruption (Brandon-Jones et al., 2014; Schmitt and Singh, 2012). While in some studies, concurrent strategies are categorized under reactive strategies, according to Hollnagel (2006), the two are separate concepts in terms of the disruption phase in which concurrent strategies are the ones that are implemented during the disruption as an adaptation or first response to such events (Carvalho, Azevedo, and Cruz-Machado, 2012; Knemeyer, Zinn, and Eroglu, 2009).

According to Zsidisin and Ellram (2003), supply chain resilience can be implemented by constructing a balance between buffer-oriented strategies, such as safety stock and process-oriented strategies, such as monitoring suppliers. Although buffer-oriented strategies reduce disruption loss, process-oriented ones also play an important role in sensing the probability of any disruptive event (Vanpoucke and Ellis, 2019). On the other hand, two different points of view on the strategies to manage such events are robust strategies, which aim to sustain the performance under disruption

(Qiang, Nagurney, and Dong, 2009) and resilient strategies, which focus on the recovery of the supply chain after the disruption (Ivanov et al., 2016). Much of the available supply chain resilience studies selected in this study revealed that the strategies broadly focus on improving particular supply chain capabilities: agility, flexibility, redundancy and collaboration, which, as mentioned before, addressed as the most critical supply chain resilience components (Jüttner and Maklan, 2011; Ponis and Koronis, 2012). While new strategies and aspects of supply chain resilience are being developed constantly, the background research revealed the fact that extant literature lacking on resilience in the fashion industry context (Lemieux et al., 2012; Martino et al., 2017; Rinaldi and Bandinelli, 2017). Hence, the scope of the thesis is narrowed down to fashion supply chain resilience using a partial systematic literature review approach in the following section.

CHAPTER 3: RESILIENCE IN FASHION SUPPLY CHAINS

3.1. Fashion Supply Chains

According to Mckinsey's State of Fashion 2024 report, in today's highly competitive world, the fashion industry is one of the key pillars of the global economy, generating $2.5 trillion in annual revenues before the recent COVID-19 outbreak while employing more than 300 million people worldwide. However, one major challenge in fashion is that it is volatile, meaning that it must change (Aagerup, 2011). The speed of the variety of looks and the availability of the products, in other words, the consumers' demand for change in the fashion industry, shapes today's dynamics of fast fashion (Ertekin and Atik, 2015). According to Şen (2008), the fashion industry is characterized by high product variety, uncertainties in demand and supply, short life cycles, and highly impulsive buying behavior. Fast fashion adapts a business model to rapidly react to the market impulses while providing the most fashionable clothing items at low cost in a short time, which leads to a continuous increase in the annual collections presented to the consumers (Mehrjoo and Pasek, 2016).

Within the literature, many studies have pointed out the major characteristics of the fashion apparel industry , such as short life cycles, high demand volatility, low predictability, long time-to-market, high impulse purchases, high customer expectations, wide product variety (Brusset and Teller, 2017; Caniato et al., 2012; Chen, Das and Ivanov, 2019; Christopher, Lowson and Peck, 2004; Martino et al., 2017; Masson et al., 2007; Mehrjoo and Pasek, 2016; Vaagen and Wallace, 2008). Such challenges in industry characteristics force fashion companies to adapt to a highly time-sensitive environment where they are in constant search for newness, speed and cost-effectiveness (Ghemawat and Nueno, 2006). Recognizing these industry-specific challenges highlights the importance of understanding fashion supply chains' extensive and complex nature. Fashion institution has complex supply networks involving a large number of partners, including yarn and fiber suppliers, fabric manufacturers, apparel manufacturers, warehouses, brand owners, distributors, retailers and end consumers (Cao et al., 2008; Macchion et al., 2015). The global fashion supply chain operates in a vast scope of processes, including many different actors from all levels of production involving millions of people in which a piece of garment travels through various ranges of actors such as suppliers, manufacturers, carriers, distributors, retailers and customers themselves, in a global spectrum. As

ČiarnienÄ—a and VienaÅ¾indienÄ— (2014) demonstrates, generally while clothing items are designed in one country, they are manufactured in another, and sold in a third. This complex web of relationships and processes brings into focus the varying operational models in the fashion industry.

In general, two major supply chain models exist in the fashion industry: the traditional push model and the new customer-centric pull mode. While the push-based fashion supply chain is a continuous flow model and, in this model, most manufacturers, suppliers and distributors have the power, the pull-based model is less of a product-centric one where the power balance shifts to customers and is mostly adopted by the fast fashion brands. While all fashion models involve the seasonality element, the design of supply chains may differ across fashion markets.

Today's fashion market is unpredictable since it heavily relies on consumer taste and spending power. Moreover, the traditional fashion industry is currently being redefined with digital disruptions while shifting from offline to online channels. The fashion industry is being reshaped with the acceleration of innovative digital technologies such as e-commerce, social media, artificial intelligence, and advanced data analytics. Disruptive trends in the fashion industry that allow customization, such as augmented and virtual reality-driven customer experience and wearable technologies provided by smart fashion, are now reshaping consumer behavior into a more customer-centric business model in which consumers are spending more time shopping online. However, improved infrastructure and information technology led to more complex networks where fashion supply chains became even more vulnerable to such disruptions (Manuj and Mentzer, 2008). Through the years, various industrial disasters caused severe disruptions in the fashion industry, such as fire accidents at the Tazreen garment factory in Bangladesh and at the Ali Enterprises in Pakistan (2012), the collapse of the Rana Plaza building in Bangladesh, which is one of the deadliest fashion industry disasters in modern history. Recently, COVID-19 outbreak unveiled the shortcomings of existing fashion supply chains globally and, accordingly, revealed the necessity of building resilient supply chains (McMaster et al., 2020).

The extant research on fashion supply chains reported various natural and man-made disruptions that can lead to various risks such as financial, chaos, market, ethical and environmental risks (Caniato et al., 2012; Christopher, Lowson, and Peck, 2004; Masson et al., 2007; Perry, Wood, and Fernie, 2015). While financial risks could arise from stock-outs and product obsolescence, mistrust among supply chain partners may

yield chaos risks, and market risks may arise from not reacting fast enough to market changes. Ethical risks arise from supply chain trends such as outsourcing manufacturing functions to developing countries, causing ethical issues such as child labor and worker exploitation (Smestad, 2009). In addition, rapidly changing fashion trends encouraged consumers to chase these trends. Reasonable prices stimulate excessive consumption, which has a large amount of environmental footprint because of water, energy and chemicals used in manufacturing as well as waste generated in production and transportation processes, causing environmental risks. Nevertheless, evidence suggests that such disruptions may lead to various risks, such as loss of goodwill or environmental penalties (Lee and Vachon, 2016). All these risks indicate the necessity for supply chains in the fashion industry to evolve towards greater resilience and more substantial ethical commitments.

Disruptions in fashion supply chains not only obstruct transportation operations and cause delays but the quality of the products may also be affected (Christopher and Holweg, 2011). Moreover, such disruptions could cause other triggered events, generating a ripple or domino effect affecting the entire network. Therefore, it is vital to integrate supply chain capabilities into the operational and strategic structures of a fashion company, which in turn ensures the survival of the entire supply chain (Bevilacqua et al., 2019; Brandon-Jones et al., 2014). The extant literature proposes various supply chain management strategies, including some common phenomena as Just-in-time (JIT) and Quick Response (QR) (Bergvall-Forsberg and Towers, 2007; Bruce, Daly, and Towers, 2004; Chandra and Kumar, 2000; Christopher, Lowson, and Peck, 2004; Fernie and Azuma, 2004; Giunipero et al., 2001) to respond quickly to market demand while reducing cost (Bruce and Daly (2006); Jin et al., 2012; Seo, Kim and Lee, 2016). However, according to Makhashen et al. (2020), these traditional supply chain management strategies are not effective enough for the modern fashion industry.

3.2. Fashion Supply Chains & Resilience

3.2.1. Semi-Systematic Review

To deepen the fashion supply chain resilience-oriented knowledge, a semi-systematic literature review on works concerning fashion supply chain resilience was conducted using the following search strings with respect to the number of articles resulted (Table 6).

Table 11. Conceptual Framework for Fashion Supply Chain Literature

Search Strings	Total Number
"Supply Chain Resilience" AND Fashion	4
"Supply Chain Resilience" AND Apparel	3
"Supply Chain Resilience" AND Textile	0
"Fashion Industry" AND" Resilience	6
"Apparel Industry" AND Resilience	4
Fashion AND Resilience	265
Fashion AND Agility	61
"Fashion Industry" AND Agility	10
"Fashion Industry" AND Flexibility	27
Fashion AND Agility AND "Supply Chain"	23
Fashion AND Flexibility AND "Supply Chain"	43
"Fashion Industry" AND Risk	51
"Fashion Industry" AND Change	227
"Fashion Industry" AND "Supply Chain Management"	74
"Fashion Industry" AND Respons*	184
"Fashion Industry" AND Resil*	6
Total articles identified	**988**

The same procedures mentioned previously have been applied to the systematic literature review process, and each step of the performed research is illustrated in Figure 5. After removing duplicates, titles and abstracts of 403 unique articles were screened in the first process of selection. Articles that did not meet the selection criteria (Newbert, 2007) were excluded; 147 candidate articles remained for the introduction and conclusion review, which resulted in 92 remaining articles to be analyzed.
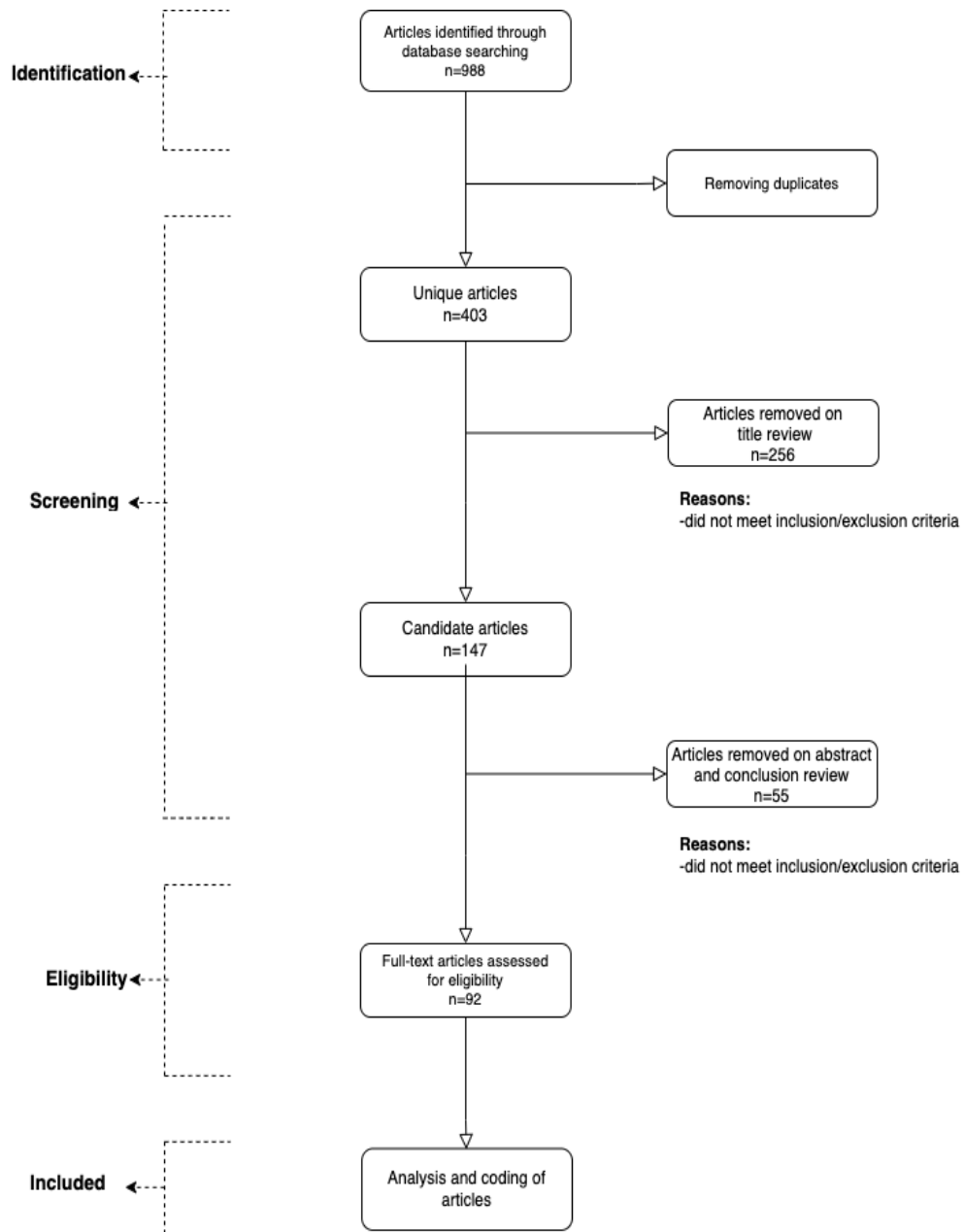
Figure 5. Review Process for Study Selection (Fashion Supply Chain Resilience)

3.2.2. Descriptive Analysis

While there exists a growing interest in supply chain resilience as mentioned before, as shown in Figure 6 also revealed the increasing attention on resilience in the fashion context (Choi and Ren 2016; Freise and Seuring, 2015; Hon Kam, Chen and Wilding, 2011; Martino et al., 2017; Mehrjoo and Pasek, 2016).
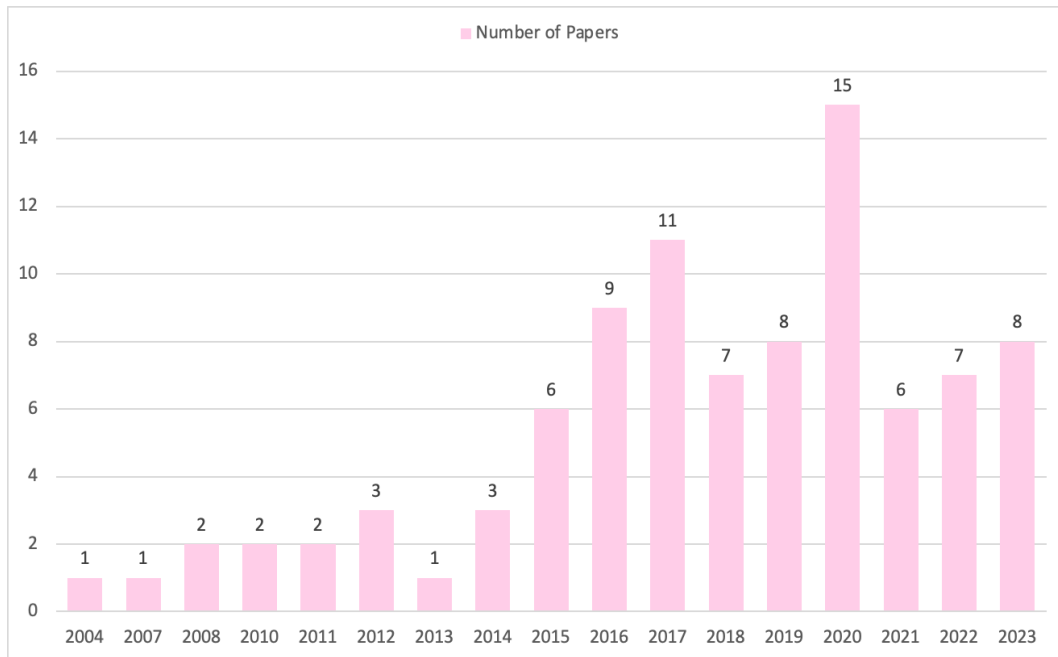
Figure 6. Year-wise Distribution of Publications in Fashion Context

Screening of 92 articles showed that articles addressing supply chain resilience in the fashion context have appeared in a myriad of academic journals, and almost half of the articles are mere instances in the respective journals they have published in. As shown in Table 7, *International Journal of Production Economics* has been the most popular journal, which is followed by *Sustainability*.

Table 12. Journals of Selected Articles and Frequency of Appearance

Journal	Number of papers
International Journal of Production Economics	6
Sustainability	5
International Journal of Production Research	4
Journal of Enterprise Information Management	4
Production Planning & Control	3
Supply Chain Management	3
Transportation Research Part E: Logistics and Transportation Review	3
Annals of operations research	2
Asia Pacific Journal of Marketing and Logistics	2
Benchmarking: An International Journal	2
Corporate Social Responsibility and Environmental Management	2
International Journal of Agile Systems and Management	2
International Journal of Logistics Research and Applications	2
International Journal of Operations & Production Management	2
Journal of Business Research	2
Journal of Fashion Marketing and Management: An International Journal	2
Journal of Risk and Financial Management	2

Table 13. (cont'd) Journals of Selected Articles and Frequency of Appearance

Operations and Supply Chain Management: An International Journal	2
The International Journal of Logistics Management	2
Others	59
TOTAL	92

In the literature, various research methodologies have been used to address the topic of supply chain resilience in the fashion context. As shown in Figure 7, six methodologies were common across the 94 reviewed articles: case study (37), survey (23), modeling (16), theoretical and conceptual (13), literature review (7) and simulation (2). Although the use of multiple methods was applied in some studies (6), each article in this instance was classified under all the methodologies applied. Moreover, the descriptive analysis findings also revealed that in the fashion context, fewer quantitative methodologies exist compared to the supply chain resilience context discussed previously.
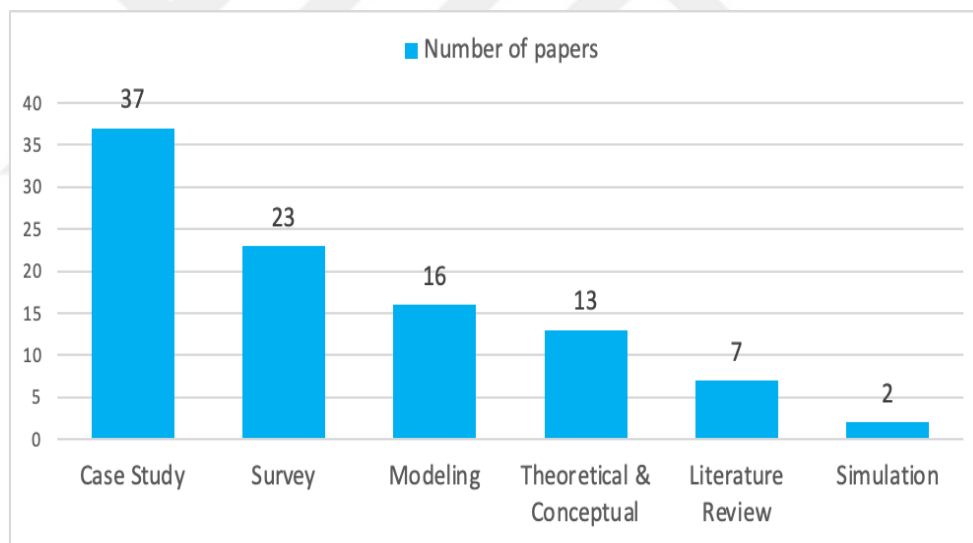
Figure 7. Distribution of Methodologies in Fashion Context

Regarding the use of theory in fashion supply chain resilience research, Table 8 shows theories grounded in the fashion supply chain context. As illustrated below, Dynamic Capabilities View is by far the most widely used theoretical lens, followed by Resource Based View.

Table 14. Distribution of Theories in Fashion Context

Theory	Number of articles
Dynamic Capabilities View	12
Resource Based View	6
Fuzzy Theory	4
Social Capital	3
Relational View	2
Agency Theory	1
Alignment Theory	1
Complex Adaptive Systems	1
Contingency Theory	1
Disruptive Innovation Theory	1
Game Theory	1
Institutional Theory	1
Relational Dynamics	1
Social Exchange Theory	1
Transaction Cost Theory	1
Upper Echelon Theory	1

3.2.3. Thematic Analysis

In today's demand-driven and time-sensitive fashion market, for a fashion company to survive in an environment full of uncertainty and unpredictability, implementing a successful supply chain strategy is crucial. Christopher, Lowson, and Peck (2004) stressed out the importance of managing three critical lead times in the fashion supply system: time-to-market, time-to-serve and time-to-react. Since customers demand products to be quickly brought to the store, considering customer satisfaction's importance in such a competitive market, minimizing lead time is also essential in fashion supply chains. Therefore, the complexity of the fashion industry, including the time factor, requires a responsive supply chain to bring the product into the market while satisfying consumer demand at its peak (Irfan, Wang, and Akhtar, 2019; Khan, Chrsitopher, and Creazza, 2012). In their study, Khan, Chrsitopher, and Creazza (2012) pointed out the importance of supply chain issues during the early stages and investigated the interface between product design and supply chain resilience and responsiveness concepts in a global fast fashion retailer. While Zhang, Vonderembse, and Lim, (2006) mentioned the trade-off between customer satisfaction and responsiveness, according to Şen (2008),

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the reduction of the time required for design development improves responsiveness. For instance, fast fashion companies such as Zara reduced design development processes and production lead times even if they led to higher costs. Recently, Giannakis, Spanaki, and Dubey (2019) proposed a cloud-based supply chain management tool to explore three dimensions of supply chain responsiveness: visibility, flexibility, and rapid detection and reaction to changes. To clarify these concepts further, the descriptive analysis of 94 articles revealed the supply chain capabilities that are focused on the fashion context, as illustrated in Figure 8.
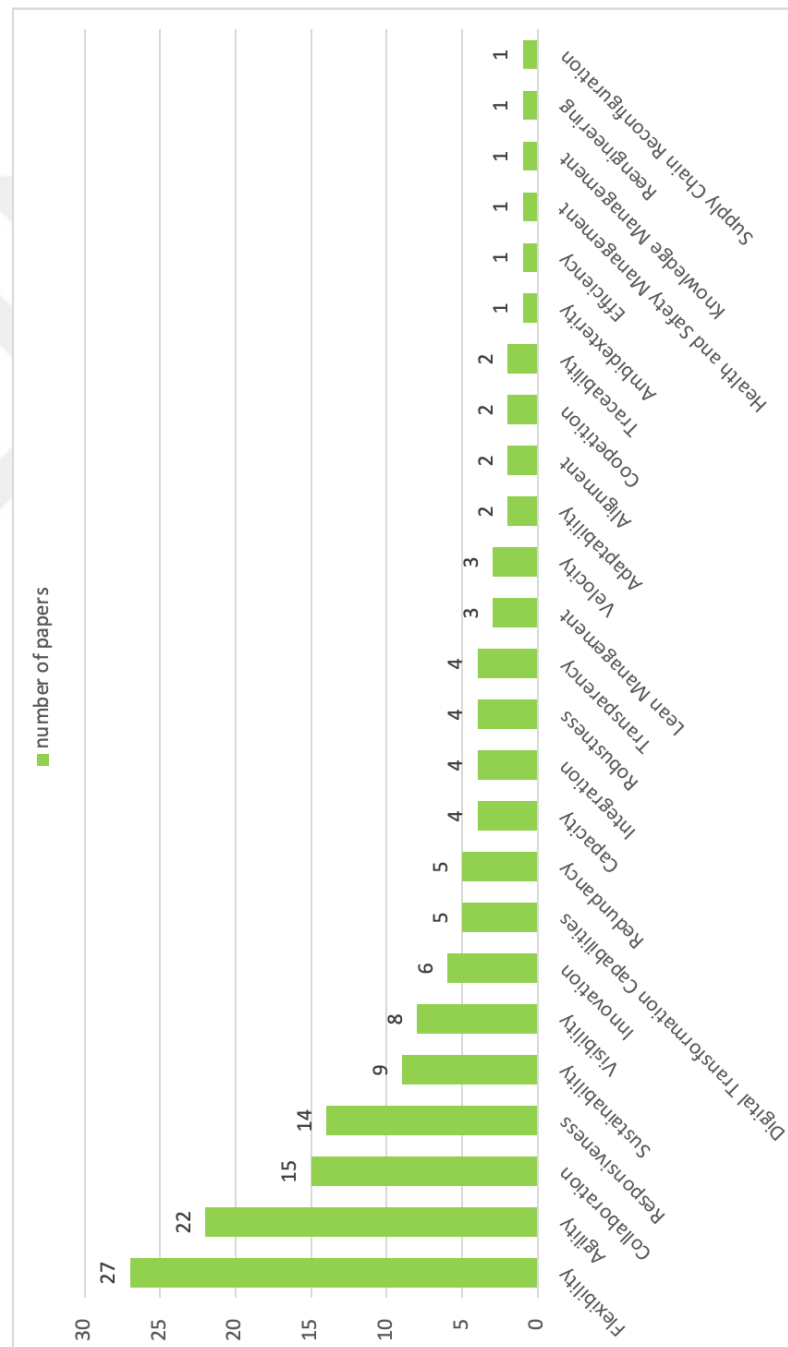
Figure 8. Distribution of Supply Chain Resilience Capabilities in Fashion Context

Among the reviewed articles, flexibility and agility, are discussed as interrelated concepts since flexibility is agreed as an influencing factor on a firm's agility and performance (Chan, Ngai, and Moon, 2017; Swafford, Ghosh, and Murthy, 2008). In their study, Chan, Ngai, and Moon, (2017) discussed that strategic flexibility and manufacturing flexibility concepts have a positive effect on supply chain agility, which eventually leads to better firm performance. The major characteristic of an agile supply chain is being responsive to market needs quickly, which is one of the main challenges in fashion supply chains (Choi, 2006; Gligor, Esmark, and Holcomb, 2015; Mustafid and Jie, 2018). With the challenges and risks stemming from such characteristics in the nature of the fashion industry, to manage uncertainty and market changes, supply chain agility is an instrumental component across the supply chain (Christopher, Lowson, and Peck, 2004; Masson et al., 2007; van Hoek, Harrison, and Christopher, 2001).

Within the literature, to encompass supply chain agility, several mechanisms have been proposed, such as managing supplier relationships (Lee, Padmanabhan, and Whang 2004), flexibility (Wagner, Grosse-Ruyken, and Erhun 2018), information systems (Swafford, Ghosh, and Murthy, 2008) and technology utilization (Malakouti, Rezaei, and Shahijan, 2017; Ngai, Chau, and Chan, 2011). Doyle, Moore, and Morgan, (2006) highlighted the importance of the buyer-seller relationship regarding agility, while Wigley and Provelengiou (2011) proposed developing strategic alliances to implement collaboration. In another study focusing on agility, Bruce, Daly, and Towers, (2004) emphasized the need to combine agility and lean paradigms in the fashion supply chain.

Although there has been a growing interest in implementing agile supply chains (Christopher, Lowson and Peck, 2004), according to Lemieux et al. (2012), supply chain resilience has not been recognized enough in the fashion industry context. Bevilacqua et al. (2019) developed a tool using fuzzy cognitive maps that is applied to a case study on a supply chain in the fast fashion apparel industry. In their study, a cognitive map was developed which aims to reveal graphically and mathematically hidden domino and/or ripple effects by investigating the factors affecting supply chain resilience. In recent years, there has also been a growing interest in supplier collaboration and cooperation capabilities to manage social and environmental issues faced by fashion companies (Perry and Towers, 2013; Köksal et al., 2017). Moreover, the textile and fashion industry has faced significant challenges,

particularly due to the disruptive effects of the COVID-19 pandemic. Understanding and adapting to these challenges has been the focus of extensive research in recent years.

Castañeda-Navarrete, Hauge, and López-Gómez (2020) examined the impacts of COVID-19 on global apparel value chains, highlighting the disproportionate impact on developing countries and proposing key policy areas for recovery. Similarly, Sumarliah, Khan and Khan (2021) examined the initial impact of the pandemic on international clothing companies' supply chains. They highlighted the limitations of lean supply chain management models and suggested that agile models might be better suited to managing supply and demand risks during crises. Furthermore, McMaster et al. (2021) adopted an international risk management lens, investigating the effects of the pandemic on the supply chains of fashion multinational corporations. Their analysis critiqued both lean and agile supply chain models and underscored the need for flexibility in handling disruptions. Chopra, Sodhi, and Lücker (2021) introduced the concept of 'commons' at multiple levels to discuss how these structures can enhance supply chain resilience and reduce the cost of adopting resilience-building strategies.

Moreover, Ye, Lau and Teo, (2023) focused on how Chinese fashion apparel companies transform their supply chains for market competitiveness. They identified the role of product context and key enablers for differentiated transformations in supply chain strategies. Tarigan et al. (2021) explored the impact of various supply chain factors on sustainable advantage in Indonesia's manufacturing industry during the COVID-19 pandemic. They highlighted the role of internal integration, supply chain partnership, agility, and resilience in achieving sustainable advantages. In the same year, Palm, Cornell, and Häyhä (2021) focused on circular economy models within the fashion industry. They argued for a more holistic approach by considering the social-ecological perspective, emphasizing that addressing only material flows is insufficient for achieving sustainable circularity. Caspersz et al. (2022) investigated the adverse impact of COVID-19 on global textile supply chains, with a particular focus on the risks of modern slavery and labour exploitation.

Verdone, Cantarero, and Puig (2021) explored the resilience strategies adopted by Spanish textile companies. Their research emphasized the role of firms, relationships, and institutions in their survival, highlighting the benefits of active involvement in the local context. Ahmed and MacCarthy (2021) discussed the

importance of traceability in the textile and apparel industry and examined how blockchain technology can enhance traceability and transparency. Additionally, Rai et al. (2021) investigated the responsiveness of supply chains in the Indian garment industry across different stages. Their findings highlighted the significance of collaboration, sourcing flexibility, and order fulfilment flexibility as key factors influencing responsiveness.

The following year, Choksy et al. (2022) investigated the Pakistani apparel sector, categorizing suppliers into different types and highlighting the variations in resilience strategies based on governance modes and pre-crisis upgrading practices. Similarly, Arania, Putri, and Saifuddin (2022) provided an economic perspective by analyzing the impact of COVID-19 on the textile and fashion industry, particularly in Indonesia. They emphasized the need for organizations to innovate and adapt their strategies rapidly. Irfan et al. (2022) explored the enablers of supply chain resilience in a Pakistani textile producer, highlighting the significance of dynamic capabilities and knowledge management. Additionally, Milewska (2022) investigated the impact of the COVID-19 pandemic on the supply chains of Polish clothing companies. The study identified key disruptions in supply, production, and distribution and outlined short-term responses and long-term strategic changes in logistics strategies. Su et al. (2022) examined the impact of the COVID-19 pandemic on the textile and apparel supply chains in Bangladesh and China. They identified factors affecting a firm's resilience to disruptions, including firm size, channel diversification, sourcing methods, and product types.

Dwaikat et al. (2022) further identified four key capabilities: retooling, repurposing, recalibrating, and reconfiguring, collectively termed as the '4Rs', essential for improving supply chain resilience based on interviews with multinational corporations during the COVID-19 pandemic. Rezaei, Hosseini, and Sana (2022) revealed that data analytics capability can enhance competitive advantage in the textile industry, with supply chain resilience and organizational flexibility serving as key mediators. Centobelli et al. (2022) explored the transition from fast fashion to slow fashion as a pathway for creating more resilient and sustainable supply chains. Their study stressed the importance of legislative support and sustainable practices. Regarding sustainability, Leal Filho et al. (2022) analyzed the impact of COVID-19 on the sustainability of the textile, apparel, and fashion industries, particularly in the European context. They discussed how disruptions led to stock control problems and

recommended implementing more sustainable practices.

More recently, Hsu et al. (2023) complemented these studies with an integrated quality function deployment approach to enhance fashion supply chain resilience and sustainability. Their research underscored the importance of agility, adaptability, and real-time risk monitoring in navigating the complex landscape of supply chain risks. Chen (2023) further explored how blockchain technology can make the fashion industry more sustainable by improving transparency, security, and traceability in fashion supply chains. Islam et al. (2023) examined how supply chain competencies helped the garment industry in Bangladesh overcome the COVID-19 crisis. Their advanced analytical methods identified key factors critical for resilience, including health and safety management and technological innovation. Last but not least, Warasthe, Brandenburg, and Seuring (2022) conducted a review of 127 studies on sustainable supply chain management in the textile and apparel industry. They highlighted the need for greater integration between economic and non-economic risk management in the industry.

CHAPTER 4: THEORETICAL FRAMEWORK

4.1. Dynamic Capabilities View (DCV)

Dynamic Capabilities View emerged from the Resource-Based View (RBV) of the firm in the late 1980s and early 1990s, emphasizing that firms' internal resources and capabilities are the primary source of competitive advantage (Barney, 1991). The theory was first introduced by Teece and Pisano (1994) and further expanded upon in their collaborative work with Shuen (1997). The term 'dynamic capabilities' was also formally introduced by Teece, Pisano, and Shuen in 1997. They proposed that firms require abilities beyond operational effectiveness to adapt to rapidly changing environments, which they termed 'dynamic capabilities' (Teece, Pisano and Shuen, 1997).

While RBV focuses on the value of resources and capabilities, DCV stresses the importance of dynamically managing these resources and capabilities in response to environmental changes (Teece, Pisano and Shuen, 1997). In conditions of stability, RBV may sufficiently explain the achievement of a competitive advantage, as the same resources and capabilities can be utilized over an extended period (Barney, 1991). However, in turbulent conditions characterized by rapid and frequent change, such as the extreme conditions considered in this thesis, the relevance of DCV becomes more apparent. DCV emphasizes the ability to swiftly detect changes in the environment, seize new opportunities, and transform resources accordingly (Teece, Pisano and Shuen, 1997).

Teece, Pisano and Shuen (1997) conceptualized dynamic capabilities as the firm's ability to

"integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (p.516).

They proposed that firms need dynamic capabilities that enable them to sense opportunities and threats, seize these opportunities, and transform and restructure their resource base to match the changing environment. Eisenhardt and Martin (2000) further contributed to the dynamic capabilities perspective by proposing that dynamic capabilities are specific and identifiable processes such as product development and strategic decision-making. Teece (2007) further elaborated on the micro-foundations

of dynamic capabilities, focusing on their components: sensing opportunities and threats, seizing opportunities, and managing threats via reconfiguring. He also emphasized the critical role of management in coordinating and integrating resources. The theory marked a shift from the conventional static perspectives on firm resources and capabilities (such as RBV) and emphasized the role of strategic management in adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competencies (Teece, 2007).

Furthermore, Helfat et al. (2009, p.4) provided a more comprehensive definition by suggesting that dynamic capabilities are

"the capacity of an organization to purposefully create, extend, or modify its resource base".

Augier and Teece (2009) extended the role of dynamic capabilities to include the shaping of the firm's ecosystem and even influencing industry evolution. Additionally, the extant literature shows that scholars further integrated DCV with other theories. Teece (2014) further highlighted the importance of sensing, seizing, and transforming capabilities in creating and maintaining competitive advantage. He also emphasized the role of effective decision-making and management in leveraging these capabilities.

4.1.1. Key Concepts and Main Premises of Dynamic Capabilities View

The theory identifies the primary attribute of a firm as its capacity to renew competencies, which helps it achieve sustainable competitive advantage in the volatile business environment. The main premises of the DCV are given in the subsections below.

The importance of resources and capabilities*:* The theory suggests that firms need to acquire unique and valuable resources and the ability to deploy these resources effectively to achieve competitive advantage (Eisenhardt and Martin, 2000).

The emphasis on change: DCV is centered on the firm's ability to adapt, integrate, and reconfigure internal and external organizational skills, resources, and functional competencies toward changing environments (Teece, Pisano and Shuen, 1997).

The three fundamental 'dynamic capabilities': Teece, Pisano and Shuen (1997) positioned dynamic capabilities as processes that allow firms to integrate, build,

and reconfigure internal and external competences. Their foundational work highlights that dynamic capabilities can be disaggregated into the capacity (a) to *sense* the opportunities and threats, (b) to seize opportunities (mobilizing resources to address the changes, and (c) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, *reconfiguring* the business enterprise's intangible and tangible assets.

Sense: This concept refers to the ability of firms to scan, learn, and interpret signals from the external environment. While initially it was about external sensing such as detecting shifts in customer preferences, recognizing technological advancements, and identifying changes in regulations (Teece, 2007), the emphasis shifted towards internal sensing such as understanding employee capabilities, recognizing internal challenges, and leveraging intra-organizational knowledge. Further, Li and Liu (2014) highlighted the role of inter-organizational networks in enhancing sensing capabilities, suggesting that partnerships and industry collaborations can significantly improve an organization's sensing capability.

Seize: The seizing mechanism initially focused on the reallocation of resources (Teece, 2007). It includes making timely and strategic decisions, reallocating resources, and initiating new ventures or projects. Effective seizing often necessitates investments in new technologies, building or changing capacities, or reorienting market strategies.

Subsequent works, such as Helfat and Peteraf (2009), broadened the concept by introducing the notion that seizing also involves investing in new resources, reshaping market strategies, and leveraging new technologies. By the mid-2010s, the focus shifted to innovation as a pivotal aspect of seizing. Teece (2014) pointed out that being innovative is not just about new technologies, but it's also about finding new business models.

Reconfigure: The concept of reconfiguring represents the firm's ability to renew and transform its resource base in response to ongoing changes. Winter (2003) discussed the challenges in reconfiguring, especially in larger, more established firms. He argued that these firms often faced bureaucratic challenges that made reconfiguration difficult. Over time, the literature began to address the concept from an organizational agility perspective, discussing the rapid realignment of resources and strategies (Pavlou and El Sawy, 2011). Another dimension added in recent literature focused on the concept of unlearning (Akgün et al., 2007). For firms to effectively

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reconfigure, they must not only adapt and learn new competencies but also unlearn obsolete practices and strategies that no longer serve their purpose.

4.1.2. Dynamic Capabilities View in Supply Chain Resilience Context

In the context of today's highly volatile and complex business environment, the dynamic capabilities perspective is considered crucial for understanding how firms can achieve sustainable competitive advantage (Teece, 2018). Despite the challenges in operationalizing and measuring dynamic capabilities, this theoretical framework provides valuable insights into the evolutionary and adaptive nature of firms in rapidly changing environments. It has been increasingly recognized as valuable in the context of supply chain management, especially in today's volatile and uncertain business environment. DCV can help firms understand how to develop and reconfigure their supply chain capabilities to maintain a competitive advantage.

Wu et al. (2006) emphasized that the supply chain's dynamic capabilities play a significant role in developing sustainable competitive advantage. They proposed that these dynamic capabilities help firms reconfigure their supply chain resources in response to external changes, thereby maintaining their operational performance and competitiveness. Moreover, Zhou and Wu (2010) conducted a study on the role of dynamic capabilities in enhancing supply chain agility and firm performance. They found that the development of supply chain dynamic capabilities enables firms to quickly respond to changes in the market, thereby improving their operational and financial performance. Additionally, Li et al. (2009) explored the role of supply chain management practices in enhancing a firm's dynamic capabilities. They found that practices like information sharing and supply chain integration could enhance a firm's ability to sense and seize new opportunities and reconfigure its supply chain operations accordingly.

The dynamic capabilities perspective has also been applied in the context of supply chain resilience. For instance, Ponomarov and Holcomb (2009) proposed that a firm's dynamic capabilities, such as its ability to rapidly reconfigure its supply chain resources and routines, play a crucial role in enhancing supply chain resilience. Pettit, Fiksel, and Croxton (2010) also emphasized that dynamic capabilities enable firms to build and sustain supply chain resilience. They argued that these capabilities, including agility and adaptability, allow firms to manage uncertainties in supply and demand effectively and recover more quickly from supply chain disruptions. Scholten and Schilder (2015) advanced this idea further, emphasizing that dynamic capabilities

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allow firms to cultivate collaborative relationships and enhance resilience by improving information sharing and joint problem-solving.

Brandon-Jones et al., (2014) also argued that human resource practices are critical in enhancing supply chain resilience by fostering dynamic capabilities needed to sense, seize, and reconfigure operational routines in the face of disruptions. Moreover, Tukamuhabwa et al. (2017) conducted an empirical study on the impact of dynamic capabilities on supply chain resilience in the context of a developing country. Ali and Gölgeci (2019) suggested that dynamic capabilities not only aid in swift recovery from disruptions but also help in recognizing opportunities that such disruptions may present, thus leading to potential competitive advantage.

Ivanov and Dolgui (2020) emphasized that these capabilities are essential for maintaining supply chain performance during and after disruptions. Additionally, Dubey et al. (2020) illustrated how dynamic capabilities enable firms to effectively manage interdependencies and uncertainties in supply chains. The study highlighted the significance of these capabilities in building resilience and mitigating risks in complex global supply chains. Through the lens of DCV theory, Shokoohyar et al. (2022) investigated the role of big data analytics (BDA) in enhancing supply chain resilience. Their study highlights how these BDA capabilities facilitate the development of efficiency-based, adaptive, and collaborative capabilities within supply chains, enabling organizations to respond dynamically to external changes and disruptions. Similarly, Irfan et al., (2022) explored how dynamic capabilities, coupled with effective knowledge management, can foster supply chain resilience, especially in situations of high disruption and uncertainty. Moreover, the paper by Belhadi et al. (2022) highlights how additive manufacturing can foster the development of ambidextrous dynamic capabilities, crucial for adapting to and thriving in the face of global supply chain challenges.

In more recent studies, DCV has been increasingly recognized as a pivotal framework in understanding and enhancing supply chain resilience, especially in the face of global disruptions such as the COVID-19 pandemic. Dubey et al. (2023) and Kähkönen et al. (2023) both highlight the importance of digital adaptability and agility in supply chains, demonstrating how government effectiveness and the ability to reconfigure resources swiftly during disruptions can fortify supply chain resilience. This reflects a growing understanding of the interplay between macro-environmental factors, such as government policies, and micro-organizational capabilities. In a

similar vein, Daneshvar Kakhki and Deiranlou (2023) explore the mediating role of data analytics in linking supply chain integration with agility and adaptability, suggesting that dynamic capabilities can be effectively leveraged through advanced data management.

Furthermore, Ruel and Baz (2023) investigate the effects of supply chain disaster readiness on resilience and robustness and their subsequent impact on financial performance. Their findings underscore the significance of preparedness in navigating crises, adding a nuanced perspective to the relationship between supply chain robustness and financial outcomes. Moreover, Pu, Li and Bai, (2023) explored the influence of proactive and reactive supply chain resilience on sustainable competitive advantage, focusing on mitigating operational vulnerabilities.

4.1.3. Dynamic Capabilities View in Fashion Context

The fashion industry, which is characterized by its fast-paced, ever-changing nature, also provides an interesting context to study dynamic capabilities. Fashion firms often need to respond quickly to shifts in consumer tastes and trends, making dynamic capabilities a crucial determinant of their success. The fast fashion business environment necessitates a high degree of resilience due to its rapid trend cycles and demand uncertainty. Bruce and Daly (2006) studied the fast-fashion business model and found that dynamic capabilities are critical to these firms' success. They proposed that fast-fashion firms leverage their dynamic capabilities to rapidly respond to changing fashion trends and provide consumers with up-to-date and affordable fashion items. Tokatli (2008) underscored the necessity for these capabilities to manage the time-sensitive processes and changing consumer preferences inherent in the fast fashion industry. More recently, Choi (2020) investigated the role of dynamic capabilities in enhancing sustainability and resilience in fashion supply chains amidst increasing environmental concerns.

Overall, the literature suggests that the DCV provides valuable insights into the operations of fashion firms. It indicates that dynamic capabilities are crucial for fashion firms to navigate the fast-paced and ever-changing fashion industry effectively and to respond to the rising demand for sustainable fashion. In addition to DCV, this thesis expands its theoretical grounding by integrating Resource Orchestration Theory, which is reviewed in the following section. By integrating both views into this thesis, it is aimed to ensure a more holistic understanding of how firms in the fashion supply chain achieve resilience and sustain competitive advantage.

4.2. Resource Orchestration Theory (ROT)

ROT, building upon the RBV, is a growing area of interest that has caught the attention of scholars in operations management in recent years (Hitt, 2011; Crook and Esper, 2014; Hitt, Carnes and Xu, 2016). While RBV posits that firms with valuable, rare, inimitable, and non-substitutable resources (VRIN) can achieve superior performance (Barney, 1991),

"possessing resources alone does not guarantee the development of competitive advantage" (Sirmon et al., 2011, p. 1391).

Priem and Butler (2001) pointed out this gap, often referred to as the 'black box', between just having resources and achieving better results. ROT emerged to address this gap, focusing on the processes and managerial decisions involved in *structuring*, *bundling*, and *leveraging* resources.

Early works by scholars like Sirmon and Hitt (2003) began to shed light on the importance of resource orchestration, emphasizing the roles of managers in effectively structuring and deploying resources. Expanding on their earlier work, Sirmon, Hitt and Ireland (2007) delineated the processes of structuring, bundling, and leveraging resources, providing a clear framework for understanding ROT. Later, they also introduced the concepts of *breadth*, *depth*, and *lifecycle* to provide a multi-dimensional perspective on how resources can be orchestrated across different levels and stages of the firm (Sirmon et al., 2011). ROT's integration with dynamic capabilities (Helfat et al., 2009) offered insights into how firms manage their current resources and adapt, renew, and reconfigure their resource base in response to a changing business environment. Similarly, Hitt et al. (2011) also extended ROT by exploring how dynamic capabilities affect the firm's resource portfolio.

4.2.1. Key Concepts and Main Premises of Resource Orchestration Theory

The theory rests on two critical aspects: the actions taken on resources (structuring, bundling, leveraging) and the dimensions in which these actions occur (breadth, depth, life cycle).

Structuring, Bundling, and Leveraging:

Structuring refers to firms acquiring, accumulating, and divesting resources (Sirmon, Hitt and Ireland, 2007). This initial stage concerns decisions about which resources to invest in, maintain, or let go. This step is foundational; by efficiently

structuring resources, firms set the stage for how these resources will be further bundled and leveraged.

Once resources are structured, they must be combined or bundled to form capabilities. Bundling involves integrating and combining resources to form capabilities (Sirmon, Hitt and Ireland, 2007). This step involves synergizing different resources to create value, which is more than the sum of the individual resources (Hitt, Carnes and Xu, 2016). ROT emphasizes how resources can be 'bundled' to create unique capabilities. This bundling can lead to the development of competitive advantages, as the resulting capabilities might be difficult for competitors to imitate.

Leveraging is the application of the bundled resources or capabilities. This refers to how firms utilize their resource bundles in operations to extract the maximum potential value (Sirmon and Hitt, 2003). Firms must effectively employ their bundled resources across operations to achieve the desired value (Sirmon, Gove and Hitt, 2008).

Breadth, Depth, and Life Cycle:

Breadth is the extent to which resource orchestration occurs across the entirety of the firm (Sirmon et al., 2011). It's about ensuring that resources are managed in a manner that is consistent and harmonious across different functional units and domains of the firm.

Depth focuses on resource orchestration across various hierarchical levels of the firm, such as top management, middle management, and operational levels (Sirmon, Hitt and Ireland, 2007; Sirmon et al., 2011). Effective orchestration must consider the distinct roles and perspectives of these levels, recognizing that each level may have its unique resource needs and contributions.

The life cycle emphasizes the need for resource orchestration to be adaptive to the different stages of a firm's maturity, which are startup, growth, maturity, or decline (Sirmon et al., 2011). As a firm evolves, its resource needs, challenges, and opportunities shift, and its resource orchestration strategies must be adaptive enough to accommodate these changes.

4.2.2. Resource Orchestration Theory in Supply Chain Resilience Context

Despite being a relatively new concept (Sirmon, Hitt and Ireland, 2007; Sirmon et al., 2011), ROT has been recognized as a valuable tool not only in organizational studies but also in various other areas, notably in supply chain management (Hughes et al., 2018; Kristoffersen et al., 2021). In their study, Liu et al. (2016) observed

connections between supply chain integration and IT competency within manufacturing. Gong et al. (2018) suggested a framework under ROT for multinational companies to manage their resources in promoting sustainability knowledge through multi-tiered partnerships. Similarly, Hughes et al. (2018) examined how individual resources and varied configurations aid in profit maximization among manufacturers.

Additionally, Burin, Perez-Arostegui, and Llorens-Montes (2020) studied the role of IT proficiency in boosting supply chain flexibility using ROT and found that high IT skills were crucial for effective orchestration. More recently, Queiroz et al., (2022) emphasized the significance of the resource orchestration theory (ROT) in understanding how firms respond to major disruptions like COVID-19. It reveals that while supply chain alertness contributes to efficiency, in severe disruptions such as the pandemic, supply chain resilience does not heavily depend on efficiency; instead, a focus on resource reconfiguration and alertness becomes crucial to enhancing resilience in supply chains.

Moreover, recent studies on ROT have significantly enhanced our understanding of supply chain management, particularly highlighting effective strategies during global crises like the COVID-19 pandemic. El Baz, Ruel and Ardekani (2023) and Skipworth et al. (2023) both emphasized the critical role of resource orchestration in navigating these challenges. While El Baz, Ruel and Ardekani (2023) focused on the impact of supply chain resilience and robustness on financial performance across French firms, Skipworth et al. (2023) extended ROT to a network level, exploring how organizations across various countries leverage resources in response to extreme uncertainty.

In addition, Lin et al. (2023), Yin (2023), Xu et al. (2023) and Lu, Wang and Wang, (2023) investigated how digital transformation influences supply chain resilience. Lin et al. (2023) examined the alignment between digitally-driven business capabilities and supply chain governance, identifying mechanisms that enhance resilience. Yin's research investigated digital transformation strategies for achieving high supply chain resilience, revealing complex causal relationships in the manufacturing sector. In a similar vein, Lu, Wang and Wang (2023) analyzed the impact of supply chain governance on resilience in China, focusing on the mediating role of supply chain finance and the enhancing effect of digital technology adoption. Additionally, Xu and colleagues provided a framework for resource orchestration in

the adoption of big data analytics, emphasizing resource management's role in supply chain planning. Similarly, the study by Dey et al. (2023) integrates ROT with the knowledge-based view to examine AI adoption in Vietnamese small and medium enterprises (SMEs), revealing how leadership and organizational mechanisms facilitate AI-driven supply chain resilience.

4.2.3. Resource Orchestration Theory in Fashion Context

The increasing integration of resource orchestration theory into the fashion industry is evident in recent research, highlighting its potential to unravel complexities inherent in the fashion supply chain. In this regard, Malik, Ghaderi, and Andargoli (2021) emphasized the importance of supply chain traceability and transparency in gaining a competitive advantage in the fashion industry. Malik and colleagues provided evidence that traceability and transparency are mutually constitutive and potentially synergistic, contributing to improved financial performance. Moreover, firm size and international presence are identified as determinants that affect the capacity to leverage these capabilities.

Saccani, Bressanelli, and Visintin (2023) highlighted the urgent need for the textile and fashion industries, known for their considerable environmental footprint, to transition towards a Circular Economy (CE). Their empirical investigation into the Prato regenerated wool district in Italy sheds light on the challenges faced during this transition and proposes a circular supply chain orchestration approach as a potential solution. They contributed a framework that integrates resource orchestration, supply chain orchestration, and CE principles to offer responses to the challenges inherent in CE adoption in the fashion industry.

Similarly, Sandberg (2023) provided an in-depth examination of the orchestration capabilities required in circular textile supply chains, focusing on a case study of a Swedish fashion retailer. The study identifies three primary orchestration capabilities: managing circular consumer offerings, overseeing circular supply chain activities, and fostering partnerships. Central to these findings is the dual role consumers play in the circular ecosystem, acting both as customers and suppliers of raw materials.

The fashion industry's evolution towards circularity necessitates a nuanced understanding of resource orchestration theory, and it is evident that effective resource orchestration is crucial for sustainable transitions in the industry. Through the theoretical lens of ROT, this thesis aims to understand how fashion supply chains

strategically deploy, bundle, and leverage their resources to adapt and recover from extreme conditions, ultimately building resilience.

4.3. Complex Adaptive Systems (CAS)

CAS is a multifaceted concept with roots in various fields like evolutionary biology, non-linear dynamical systems, and artificial intelligence. The theory focuses on the dynamic interaction between a system and its environment, as well as their co-evolution. The theory is characterized by the system's dynamic ability to adapt and respond to changes (Choi, Dooley, and Rungtusanatham, 2001; Day, 2014). They are systems that consist of multiple agents that interact with each other, leading to the emergence of higher-level system behavior that cannot be predicted from the behaviors of the individual agents (Holland, 1992).

Drawing from Choi, Dooley, and Rungtusanatham (2001), CAS can be described as systems where various interconnected parts or agents adjust and adapt based on the environment and their own system. These systems have a unique ability to self-organize; over time, they modify their internal and external connections to evolve (Choi, Dooley, and Rungtusanatham, 2001).

4.3.1. Key Concepts and Main Premises of Complex Adaptive Systems

According to Choi, Dooley, and Rungtusanatham (2001), three key elements in CAS are *internal mechanisms*, *environment*, and *co-evolution*. 'Agents' within the system follow certain rules or 'schemas' that guide their actions, leading to *self-organization* and *emergent* phenomena. The system dynamically interacts with its external environment, which itself can be a complex system, and both co-evolve over time.

Internal Mechanisms:

Agents: Agents in a CAS refer to the entities within systems. These agents possess the capacity for agency, meaning they can intervene in events and influence outcomes. Agents have schemas—mental frameworks that consist of norms, values, and beliefs—that guide their behavior. Importantly, not all systems that are complex have agents with an agency.

Self-Organization and Emergence: Unlike systems controlled by a single entity, CAS is self-organizing. They display emergent behaviors that arise spontaneously and are not externally imposed.

Connectivity: A CAS is an intricate network of agents and their connections.

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The level of these connections is crucial; too few and the system becomes random, too many and it may become constrained. At a critical level of connectivity, interesting complex behaviors and chain reactions emerge.

Dimensionality: This refers to the degrees of freedom or autonomy that individual agents have. Controls like rules and regulations can reduce this dimensionality, making the CAS more predictable but less capable of emergent, creative outcomes.

Environment:

The environment for a CAS comprises elements not contained within the system but that interact with it. This environment is 'dynamic' and 'rugged', meaning it changes and can present obstacles. It influences and is influenced by the CAS, with ever-changing and complex elements. The environment plays a critical role in the adaptability, challenges, and survival of a Complex Adaptive System.

Dynamism: The environment is ever-changing, and its dynamism comes from the fact that it is comprised of other CASs. These systems constantly evolve, influencing each other in both minor and major ways. Changes can occur through modifying the system boundaries, altering the rules or norms (schemas), or modifying performance criteria. Any change in one CAS triggers changes in other systems, creating a ripple effect of transformations.

Rugged Landscape: The environment presents complex, rugged landscapes that are a challenge for optimization. Unlike simple landscapes, where you can easily find the best state, rugged landscapes are filled with local peaks and valleys. This complexity arises from the tightly coupled components of the system. When components can be optimized individually, finding the global optimum is easier. Nevertheless, when they are interdependent, there could be multiple local optima, making the 'best state' difficult to find. Additionally, this landscape is not static; it is dynamic, further complicating optimization efforts.

Co-Evolution:

Unlike traditional management or economic theories that view systems and environments as separate entities, Complexity Theory argues that CAS and its environment co-evolve through complex feedback loops involving competition, cooperation, and shared resources. Both CAS and its environment are in a state of constant interaction and adaptation, which makes the relationship between a CAS and its environment dynamic and bidirectional.

Quasi-Equilibrium and State Change: CAS tends to maintain a quasi-equilibrium, a balance point sometimes referred to as the 'edge of chaos', which allows it to maintain order while reacting to changes. However, major disruptions can push the system into a different state or pattern.

Non-Linear Changes: The behavior of CAS is non-linear, meaning small changes can have massive impacts, and large changes may lead to modest effects. This makes the system highly sensitive to even slight fluctuations in the environment.

Non-Random Future: Although it is difficult to predict the future behavior of a CAS precisely, the future is not entirely random or arbitrary. The system tends to display recurring behavior patterns, which offer a level of foresight into how the system is likely to behave over time.

In summary, the study of CAS offers insights into the complex, interconnected, and evolving nature of systems. Understanding these facets is crucial for recognizing and managing supply networks as Complex Adaptive Systems.

4.3.2. Complex Adaptive Systems in Supply Chain Resilience Context

Several researchers, including Kim, Chen, and Linderman (2015) and Nair, Narasimhan, and Choi (2009), emphasized that the CAS perspective is valuable when discussing the structure of supply chain networks. Pathak et al., (2007) specifically mention that supply chains are prime examples of CAS. They argued that these chains inherently adapt due to the interplay of different elements or nodes in the network and sustain changes over time.

When applying the principles of CAS to supply chains, it is observed that such networks comprise various independent elements that make decisions to ensure their survival. Consequently, the whole system goes through a phase of evolution and self-organization (Pathak et al., 2007). Choi, Dooley, and Rungtusanatham (2001) highlighted that supply chains are complex and constantly changing. Sometimes, disturbances in the supply chain might emerge without the main company realizing its potential implications. Due to the deeply interconnected nature of supply networks, minor disruptions can snowball and become significant threats to the main company (Fiksel and Fiksel, 2015; Hearnshaw and Wilson, 2013).

Since a CAS serves as an advanced lens through which the dynamic nature of interconnected systems can be understood and studied, this thesis aims to examine fashion supply networks as complex systems by utilizing the CAS perspective. Within these systems, individual companies have the capability to adjust and rearrange their

connections, especially when disruptions occur in the supply chain.

To the best of our knowledge, research grounding CAS in the fashion industry has been relatively limited, offering a rich yet underexplored field of study. In this context, the study by Ciccullo, Pero, and Patrucco (2023) emerges as a pivotal contribution, shedding light on the complex dynamics of circular supply chains (CSCs) through the lens of CAS. By analyzing Italian sustainable start-ups, the study illuminates how these companies, as agents within the CAS framework, dynamically configure and coordinate their CSCs, a process reflective of key CAS concepts such as adaptation, emergence, and self-organization. This research enhances the understanding of CSCs from a CAS perspective, particularly in the dynamic and ever-evolving fashion industry, showcasing how these systems exhibit complexity, interconnectivity, and the capacity for continuous evolution in response to environmental and internal changes.

CHAPTER 5: QUALITATIVE METHODOLOGY

While investigating a phenomenon that is at early research development stages, such as the impacts of extreme disruptions on fashion supply chains, mixed methods research design is an appropriate approach (Yin, 2003) to build new knowledge in the field. Moreover, combining more than one type of research approach is still needed in the supply chain management area due to a lack of studies that mix both qualitative and quantitative methods (Golicic and Davis, 2011). Therefore, to understand such a phenomenon, in this thesis, an exploratory sequential mixed method design is employed (Hirschman, 1986).

An exploratory sequential mixed methods design is a research approach that involves two phases - a qualitative phase followed by a quantitative phase. The qualitative phase is conducted first and consists of collecting and analyzing qualitative data. This phase may use various qualitative methods such as interviews, case studies, or thematic content analysis. The purpose of the qualitative phase is to gain an in-depth understanding of the research topic and to identify essential themes or patterns. The results of this phase are then used to develop or inform the subsequent quantitative phase. In the quantitative phase, a survey or other type of quantitative data collection method is used to gather more structured and measurable data (Creswell and Clark, 2017).

In this thesis, the research methodology is designed as a three-stage progression, incorporating a mixed-methods approach to comprehensively analyze and interpret the data, which is illustrated in Figure 9. The preliminary phase commences with a rigorous literature review, setting the stage for a qualitative research design. Stage two, the qualitative study, utilizes semi-structured interviews and news content analysis to address the research questions RQ1, RQ2, and RQ3. These questions probe into the sources of disruptions in fashion supply chains, the essential capabilities for resilience, and the barriers to develop resilient supply chains. Subsequently, stage three shifts focus to a quantitative study, employing mathematical modeling informed by insights gained from the earlier qualitative phase. This stage aims to answer RQ4 and RQ5, which involve the classification of companies based on their resilience capabilities and the strategic combination of these capabilities in response to disruptive events.
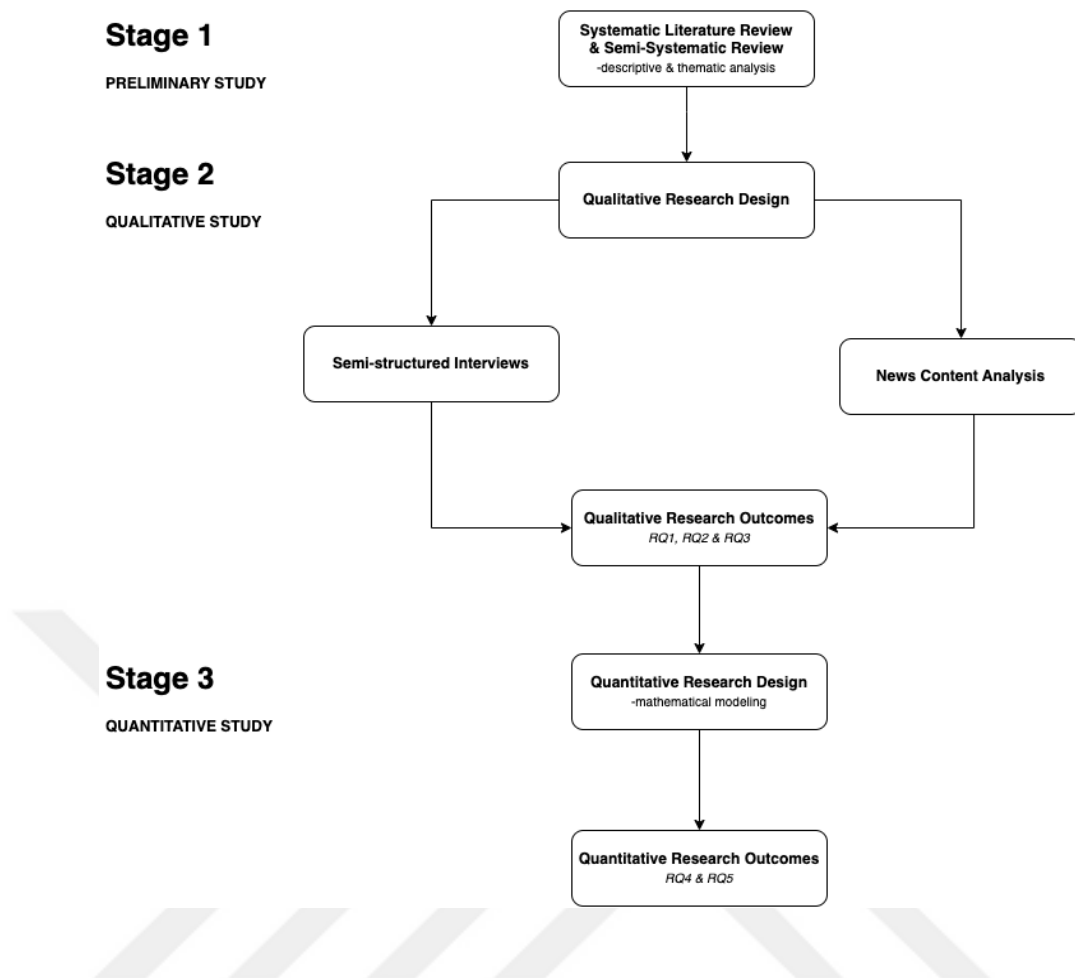
Figure 9. Exploratory Sequential Design Framework

5.1. Semi-structured Expert Interviews

In the initial phase of the thesis, a qualitative research design was adopted to gather an in-depth understanding of fashion supply chain resilience in extreme conditions. In this regard, semi-structured interviews were conducted with key informants from different levels of the supply chain since they provide a rich and multifaceted view of resilience in the fashion supply chain. The semi-structured expert interviews allowed us the flexibility to explore the insights and experiences of informants from mid- to top-level management position supply chain decision-makers of the fashion industry. They provided an understanding of the perspectives of different stakeholders in the supply chain, including manufacturers, suppliers, distributors, retailers, and business customers, while providing a more holistic understanding of the topic.

Data Collection

The sample size was not pre-determined since the aim was to achieve saturation

of emerging patterns. Particularly, the sample size is viewed as satisfactory when compared with Creswell's (1998) recommendation of a sample size of 20-30. Through purposive sampling, twenty semi-structured interviews were conducted with key informants from different levels of the supply chain to capture a diverse range of viewpoints in the fashion industry. Since the goal is to understand a phenomenon within a specific supply chain, selecting fashion companies from different levels through purposive sampling helped us to ensure the findings are representative of that entire chain, not just one part of it. Because different levels of the supply chain may have different best practices or face unique challenges. By using purposive sampling to include these different levels, this thesis aimed to provide a more comprehensive view of the resilience capabilities and the areas that need improvement in fashion supply chains. Moreover, by interviewing participants from different levels of the supply chain, we aim to understand the interactions and dependencies between these levels, which helps us illuminate how changes at one level might impact others.

The data were collected through semi-structured interviews with key informants from each company. Due to the COVID-19 pandemic outbreak, face-to-face meetings could not be made, and online tools were used for all the interviews. Each interview lasted for 40-60 min, and with the permission of the participants, all interviews were audio-recorded. The audio-recorded interviews were transcribed verbatim. Tables 9 and 10 include the details of the participants, interviews, and sample companies.

Table 15. Details of the Interviewees

Interviewees	Gender	Designation	Years of Expertise	Duration (minutes)
Interviewee 1	Male	Supply Chain Team Lead	5 years	52
Interviewee 2	Male	Vice President Global Sourcing	3 years	47
Interviewee 3	Male	Sustainability Senior	10 years	53
Interviewee 4	Male	Supply Chain System Development & Project Mgt. Unit Manager	4 years	66
Interviewee 5	Male	Chief Sourcing & Supply Chain Officer	5 years	51
Interviewee 6	Female	Co-Founder	2 years	52
Interviewee 7	Female	Deputy General Manager (Sales & Marketing, Supply Planning, Quality Assurance)	3 years	42
Interviewee 8	Male	Sustainability Executive	4 years	54
Interviewee 9	Male	Supply Chain Lead	3 years	52

Table 16. (cont'd) Details of the Interviewees

Interviewee 10	Male	Supply Chain Manager	20 years	46
Interviewee 11	Male	Co-Founder	20 years	42
Interviewee 12	Male	Supply Planning Manager	10 years	44
Interviewee 13	Male	Supply Chain Lead	8 years	48
Interviewee 14	Male	Supply Chain Executive	15 years	57
Interviewee 15	Male	Co-Founder	4 years	61
Interviewee 16	Female	Department Manager (Development & Production Merchandiser)	6 years	56
Interviewee 17	Female	Vice President-Marketing & Product Development	18 years	53
Interviewee 18	Female	Merchandiser Allocation & Replenishment	3 years	45
Interviewee 19	Female	Executive Director Sales Marketing	19 years	45
Interviewee 20	Male	Product Design & Development Manager	10 years	52
Interviewee 21	Female	Executive Director Sales Marketing	21 years	50
Interviewee 22	Female	Product Design & Development Manager	11 years	55
Interviewee 23	Male	Co-Founder	26 years	52
Interviewee 24	Female	Founder	14 years	51
Interviewee 25	Male	Founder	8 years	46

Table 17. Characteristics of the Companies

Company	Origin	Scope of Operations	Position in the Supply Chain	Typology	Number of employees (as of 2023)
Company 1	France	Asia, Africa, Australia, Europe, South America	Retailer	Global Clothing Retailer	50000+
Company 2	US	Asia, Europe, South America	Retailer	Global Clothing Retailer	3000+
Company 3	Türkiye	Asia, Africa, Europe, North America	Garment Manufacturer	Focal Company (production)	400+
Company 4	Türkiye	Asia, Africa, Europe	Retailer	Global Clothing Retailer	14000+
Company 5	Türkiye	Asia, Africa, Europe, North America	Retailer	Global Clothing Retailer	400+
Company 6	Türkiye	Europe	Retailer	Global Clothing Retailer	100+
Company 7	Türkiye	Europe, North America	Garment Manufacturer	Focal Company (production)	400+
Company 8	Türkiye	Asia, Africa, Europe, North America	Garment Manufacturer	Focal Company (production)	2000+
Company 9	Türkiye	Asia, Africa, Australia, Europe, South America	Garment Manufacturer	Focal Company (production)	1000+
Company 10	Türkiye	Europe	Tier 1 Supplier	Fabric Supplier	300+

Table 18. (cont'd) Characteristics of the Companies

Company 11	Türkiye	Asia, Africa, Europe	Tier 2 Supplier	Yarn Manufacturer	700+
Company 12	Türkiye	Europe	Tier 1 Supplier	Fabric Supplier	50+
Company 13	Türkiye	America, Asia, Europe	Tier 3 Supplier	Raw Material Supplier (Cotton)	50+
Company 14	Türkiye	America, Asia	Trade Firm	Trade Firm	100+
Company 15	Türkiye	America, Australia, Europe	Tier 1 Supplier	Fabric Supplier	450+
Company 16	Germany	Worldwide	Retailer	Global Clothing Retailer	15000+
Company 17	Türkiye	Europe	Retailer	Global Clothing Retailer	50+
Company 18	Spain	Worldwide	Retailer	Global Clothing Retailer	175000+
Company 19	Türkiye	America, Europe	Tier 2 Supplier	Yarn Manufacturer	1200+
Company 20	Germany	Worldwide	Retailer	Global Clothing Retailer	55000+
Company 21	Türkiye	Europe	Garment Manufacturer	Focal Company (production)	500+
Company 22	Türkiye	Europe	Tier 1 Supplier	Fabric Supplier	2500+
Company 23	Türkiye	Asia, Europe	Tier 1-2 Supplier	Semi-processed materials supplier	200+
Company 24	Türkiye	America, Asia, Europe	Tier 3 Supplier	Raw Material Supplier (Cotton)	200+
Company 25	Türkiye	Europe	Tier 1 Supplier	Fabric Supplier	100+

Data Analysis

The collected data from the semi-structured interviews were transcribed verbatim to maintain the accuracy of the participant's responses. These transcriptions provided the raw data for analysis. MAXQDA software was used to facilitate the data analysis and coding process.

In this thesis, the abductive approach was employed to bridge the gap between theoretical frameworks and empirical observations (Spens and Kovács, 2006) This method is particularly useful in logistics and supply chain research, where real-world complexities often challenge existing theories (Kovács and Spens, 2007). Abduction allows for the generation of new theories by starting with an observed fact and then seeking the most likely explanation.

Grounded in abductive reasoning, the coding process was designed to systematically analyze qualitative data, identifying themes and patterns that emerge in

the context of fashion supply chain resilience (Table 11). Drawing on the approach of Spens and Kovács (2006), this thesis adopts an analysis tailored for the logistics domain to unravel the complexities of fashion supply chains intricately. Hence, coding becomes a pivotal element in this thesis, serving as the foundation for building a robust theoretical framework that is informed by empirical evidence, essential for an in-depth exploration of resilience within the fashion supply chain context.

Table 19. Exemplary Coding of the Interviews

Quote	first order code	second order code	third order code
"I think the critical point here is to shorten the supply chain, which also reduces risk. Our company's main problem was that all products were distributed from Türkiye. To overcome this, there was a significant shift towards direct sourcing. In the long term, plans were to increase this approach and actions involved acquiring new partners or developing existing ones. For instance, in the MENA region where the company has about 100 stores, we started planning to produce and distribute products directly from there. The company has established an operational entity in the MENA region with a significant team in place. This action of managing logistics and supply chain internally in that region is crucial. It's essential for large-scale, high-turnover retail chains to shorten their supply chain. This means moving production closer to the sales regions. Instead of importing raw materials from China, we'll do direct sourcing there, producing and distributing within the region." (Company 1)	shortening the supply chain	supply chain reconfiguration	supply chain capabilities
"The most logical thing to do was to diversify the supply chain and have a broader base. 'If something happens here, there's an alternative there, this way the wheel keeps turning.' Everything we've talked about, from expanding the supply chain, reducing stock keeping units, to increasing fast minute responses, were part of this strategy." (Company 21)	extending the supply chain	supply chain reconfiguration	supply chain capabilities
"Partnerships became important, we realized that. And because of this, we continued to form partnerships with different firms. We formed new partnerships and focused on increasing them to ensure our security."(Company 25)	new partnerships	collaboration	supply chain capabilities
"We've been very transparent about freight charges since the situations are clear. We've also been transparent about the constantly changing prices. We've communicated this openly. The prices were constantly changing, especially in terms of exchange rates. For instance, a yarn we discussed at 4-5 dollars initially would be 6 dollars by the time the order was placed. We experienced these issues and shared these changes transparently. It's not like before; we don't just follow a pre-agreed price. Because in the past, in export, the price discussed six months earlier would still be valid when the order arrived. But during the pandemic, this changed." (Company 13)	market visibility	visibility	supply chain capabilities

Table 20. (cont'd) Exemplary Coding of the Interviews

"We have reached a point where road transport to Europe, especially Germany, is almost as costly as air freight. This has led to a significant increase in road transport costs. We are now preferring air freight more. For example, we do all our small-scale exports by air now. Previously, it was mainly road transport. Now, the focus is on air transport." (Company 13)	mode flexibility, logistics flexibility	flexibility	supply chain capabilities
"We cannot do to our lower-tier suppliers what our customers do to us. There are different dynamics at play higher up, but further down the supply chain, there are workers waiting for their wages, employers who need to make payments. We couldn't receive our payments from customers, but we made those payments to our suppliers during these tough times. We acted as a buffer." (Company 3)	financial buffering	financial capability	supply chain capabilities
"Those companies that quickly integrated the production of hygiene products, non-woven products, disposable items, protective clothing, gloves, and masks into their production lines were able to swiftly fill the gap. They even achieved higher turnover than expected." (Company 13)	operational agility	agility	supply chain capabilities
"We increased the number of shipping companies we work with to spread the risk. We created a module here. We are now working with 13 companies simultaneously. We prioritized shipping companies for specific districts, 'First this company goes. If we can't get a label from them, or if there's an issue, then this one goes.' These companies started putting quotas on us like, 'If their quota is full, give it to this company.' We created a serious module." (Company 4)	multi sourcing, sourcing flexibility	flexibility	supply chain capabilities
"We've started adopting a strategy of keeping stocks at our suppliers. While this does add some pressure on them, we are moving towards an automotive industry approach, not very common in textiles. By providing forecasts, we enable them to prepare, and after preparation, ensure a quick supply... This is to prevent a situation where we are left without products due to any production issues at their end. We also coordinate with our suppliers regarding drawing products from their warehouses." (Company 11)	vendor managed inventory, capacity flexibility	flexibility	supply chain capabilities
"In order to take quicker actions, we are in a period that requires management agility. You need to act quickly, and given the scale of your organization, you must ensure that the action taken spreads rapidly to every part of the organization, even to the very end of it, to guarantee that the action is implemented at every point." (Company 3)	managerial agility	agility	supply chain capabilities

Validity and Reliability of the Study

In the design of this study, various aspects were carefully considered to ensure its validity. Lincoln and Guba (1985) highlight that trustworthiness in research is established by demonstrating credibility, transferability, dependability, and conformability. Furthermore, Wallendorf and Belk (1989) propose adding 'integrity'

to these criteria to enhance the rigor of naturalistic inquiries. This study, therefore, embraces these five dimensions, aligning them with the constructivist paradigm, which forms the foundation of this research, as suggested by Wallendorf and Belk (1989).

Credibility acknowledges the existence of various interpretations of reality, as noted by Guba and Lincoln (1982). The accuracy with which these varied interpretations are captured and reflected in the results constitutes the measure of credibility. Therefore, to ensure the credibility of this thesis, a comprehensive approach was adopted, which involved engaging with field experts and asking varied questions about different disruptions during interviews. This method was crucial to gather multiple perspectives. Furthermore, the insights from these interviews were complemented with supportive data from news content. This combination of expert interviews and news content analysis played a significant role in reinforcing the overall credibility of the study.

Transferability is assessed by how well the findings of a study can be applied to other settings or groups, as described by Guba and Lincoln (1982). Transferability is addressed by collecting data from diverse contexts within the fashion supply chain, ensuring that the findings are applicable to similar settings. The study's methodical approach to sampling and data collection across different tiers of the fashion supply chain enhances its transferability.

Confirmability necessitates that the research outcomes and the process itself are not tainted by the researcher's personal biases, including their history, interests, and motivations (Guba and Lincoln, 1982). Therefore, confirmability is achieved by researcher triangulation, with multiple researchers involved in the coding and theory development process. Three researchers were involved in the data analysis process, cross-checking codes and themes to reach a consensus and reduce bias.

Integrity, as discussed by Wallendorf and Belk (1989), is addressed through prolonged engagement, rapport building and safeguarding respondent identities. In this thesis, integrity is ensured by obtaining participant consent, protecting respondents' identities, and fulfilling non-disclosure agreements as requested by some participants. These measures collectively contribute to upholding the ethical integrity of the research.

To ensure the validity of the study's data analysis, a rigorous methodological framework was utilized. This involved a thorough coding process where data was continuously compared against the theoretical models of supply chain resilience.

Additionally, the validity of the research was further reinforced through a comprehensive analysis of news content, ensuring a more robust understanding of the context and findings. Analytical strategies included in-depth interviews and thematic analysis, both of which were used to explore the complex dynamics and the adaptive strategies of fashion supply chains during extreme disruptions. The iterative process of comparing the emerging patterns from the data with existing literature provided a robust mechanism to validate the findings within the specific context of the fashion industry's supply chain challenges during extreme conditions.

5.2. News Content Analysis

In addition to the semi-structured interviews, secondary data were collected from online sources, news, etc., to provide research reliability and triangulation of the data (Yin, 2003). In this regard, a content analysis was conducted on the secondary data gathered from online news. While the semi-structured interviews offered an in-depth understanding of individual experiences, perceptions, and strategies related to resilience within the fashion supply chain, news content analysis provided a broad overview of the fashion supply chain environment, including various disruptions, their impacts, and the industry's response at large. While providing real-world examples of supply chain capabilities to build resilience, news content analysis also provided valuable insights of stakeholders in the fashion supply chain, which offers an understanding of different perspectives in the supply chain. Moreover, analyzing news content served to contextualize and broaden the understanding of the topics discussed during the interviews while providing additional information on the severity, scope, and implications of the disruptions and/or missing details left by the interviewees.

Data Collection

Online news content analysis typically involves the systematic examination and interpretation of digital news, articles, videos, and social media posts. It is a powerful method to analyze and understand the content of digital news media while providing valuable insights into the messages and themes conveyed through online news (Riffe et al., 2019). To conduct online news content analysis, a sample of online news articles, videos, or social media posts is first selected, and then a coding scheme is applied to identify relevant characteristics of the content (Neuendorf, 2016). The following figure illustrates the news content analysis procedures applied in this study.

Search Strings

"Fashion Supply Chain Resilience"
"Fashion Supply Chain Disruption"
"Textile Supply Chain Disruption"
"Apparel Supply Chain Disruption"
"Fashion Industry Disasters"
"Textile and Apparel Supply Chain Disruptions"
"Fashion Supply Chain and Risk Management"
"Fashion Industry and Covid-19"
"Fashion Supply Chain and Covid-19"
"Fashion Supply Chain and Coronavirus"
"Textile and Apparel Industry and Covid-19"
"Climate Change's impact on Fashion Supply Chain"
"Extreme Weather Conditions impact on Fashion Supply Chain"
"Fashion Supply Chain and Extreme Conditions"

```
┌─────────────────────┐
│ Keyword list created │
│ to build news        │
│ research set         │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│ Online news collected│        ┌──────────────────────────────┐
│ between 2019-2022    │───────▶│ 24 articles excluded          │
│ (n= 136)             │        │ Exclusion Criteria: meaningless,│
└─────────────────────┘        │ trivial, spam, irrelevant news │
           │                    └──────────────────────────────┘
           ▼
┌─────────────────────┐
│ Online news analyzed │
│ using MAXQDA         │
│ (n=112)              │
└─────────────────────┘
```

Figure 10. Screening Process for the News Content Analysis

Data was collected from various sources between 2019 and 2023 to explore the underlying themes in the fashion supply chain resilience context. The sources included articles from reputable newspapers (e.g., Financial Times, Forbes, Fortune, The Guardian, Reuters), magazines (e.g. Vogue, BoF – The Business of Fashion, Vox), as well as blogs and websites (e.g. Fashion United, Fibre2Fashion, WWF) which is illustrated in Appendix II. The secondary data set consisted of 112 articles with a total of 246 pages of double-spaced text.

Data Analysis

Content analysis is a research method used to study a variety of media content, including written, verbal, and visual materials (Krippendorff, 2019). The method systematically analyzes and interprets the content to identify patterns, themes, and meanings (Neuendorf, 2016). Similarly, in online news content analysis, the development of a coding scheme is another key element that accurately captures the relevant features of the content. Coding schemes typically involve a set of categories and definitions that are applied to the content in a systematic and reliable manner (Krippendorff, 2019; Neuendorf, 2016).

The secondary data's content analysis helped us identify key themes in fashion supply chain resilience. Table 12 lists the exemplary coding of the news.

Table 21. Exemplary Coding of the News

Years	News	First order code	Second order code	Third order code	Sources (accessed between 2020-2023)
2022	Bottlenecks at the ports: Labour disputes and congestion threaten US fashion supply chain	labour strikes	COVID-19 & the domino effect	disruptions in fashion supply chain	Vogue Business
2022	Fast-fashion brands claim they're cleaning up their act for the planet, but their premise might be inherently flawed	lack of transparency among fast fashion companies	greenwashing	sustainability in fashion supply chains	Fortune
2022	Climate change is coming for fashion's supply chains	increase in extreme weather conditions	regenerative agriculture, circular business models, traceability	resilience strategies	Vogue Business
2022	Fashion factory: Mango brings production closer to home in rethink on China	changes of China's role in fashion industry, growing importance of Morocco and Türkiye	alternative sourcing strategies	resilience strategies	Financial Times
2022	Vietnam apparel exports seen rising 7.4% this year to $43.5 billion	high vaccination rate	flexibility	fashion supply chain capabilities	Reuters
2022	Why Fashion Supply Chain Traceability Is A Tech Challenge That Begins With AI	impact of AI on traceability	visibility	fashion supply chain capabilities	Forbes

Table 22.(cont'd) Exemplary Coding of the News

2020	COVID-19's long wave hits Italian luxury manufacturing	supply chain delays, factory closures, capacity reduce,	long-term strategies	resilience strategies	Vogue Business
2021	'Bad apples have been exposed': can a fairer fashion industry emerge from crisis?	conscious consumers, greenwashing, need for transparency	labor standards	sustainability in fashion supply chains	The Guardian
2023	Quake Fallout Hits Retailers That Sought Supply Resilience in Turkey	the impact of port damage	Türkiye's growing importance in fashion after COVID-19	disruptions in fashion supply chain	Bloomberg
2023	Turkish Fashion Manufacturers in Earthquake-Affected Areas Resume Production	additional yarn and fabric capacity	short term strategies	resilience strategies	Business of Fashion

CHAPTER 6: FINDINGS

Understanding how fashion supply chains react to severe disruptions, particularly extreme ones, was the main focus of our study. In this thesis, we aimed to explore these extreme challenges in the fashion supply chain, with an emphasis on understanding the supply chain's response mechanisms. Through a series of carefully curated semi-structured interviews with industry experts and a news content analysis, this section aims to shed light on the multifaceted findings of this thesis. In order to eliminate duplications of each method's findings, the news content analysis was also discussed in each subsection rather than represented in a separate section. The findings section is organized and presented into three main areas. Firstly, in *'Disruptions in the Fashion Supply Chain'* we try to reveal the major events, like the COVID-19 pandemic and other subsequent disruptive events that shook the fashion industry and the domino effects. Following this, the *'Supply Chain Capabilities'* subsection explores the capabilities companies employ to build resilience in their supply chains. Lastly, *'Barriers in Building Resilient Fashion Supply Chains'* offers a perspective on these fashion companies' challenges while implementing resilient strategies. Collectively, these insights not only enrich our understanding of the current fashion supply chain dynamics but also provide a roadmap for future disruptive events in building more resilient fashion supply chains.

6.1. Disruptions in the Fashion Supply Chain
COVID-19 Pandemic

COVID-19 was declared as a global pandemic on March 11, 2020, by The World Health Organization (WHO), and caused cascading effects on global supply chains. Subsequently, several countries have declared lockdowns to slow the spread of the virus. Similarly, many companies and organisations rapidly shifted to working from home while eliminating the potential spread of the virus at the workplace. With the lockdown policies and social distancing measures, COVID-19 has caused supply and demand shocks in many countries. On the supply side, disruptions arose from restrictions in transportation, labour shortages occurred due to health concerns, and factories in affected regions were shut down. Demand shocks were felt as consumer behaviours dramatically shifted: panic buying in some sectors, decreased discretionary expenses, and increased online shopping. These shocks led to severe interruptions in both inbound and outbound flows, creating a domino effect on supply chains

worldwide. Order postponements and outright cancellations became widespread as uncertainties grew. These widespread disruptions in the supply chain compelled many businesses to take drastic measures like temporary shutdowns and significant capacity reductions, further exacerbating the supply chain bottleneck.

As operations slowed down, financial issues emerged heavily. Companies faced decreased revenues, cash flow challenges, and mounting debts. For some, especially SMEs, this led to bankruptcy or permanent closures. The financial strain inevitably spilt over to business relationships. Trust issues emerged as companies struggled to comply with the contracts, leading to renegotiations or even contract breaches. Long-standing partnerships faced crises, with many businesses re-evaluating their dependencies and looking for more resilient, diversified supply chain structures.

Moreover, COVID-19 also had broader societal impacts. Work-from-home became a new norm, which eventually led to an increase in demand for home wear collections. However, this shift in work dynamics also contributed to job losses and economic challenges for many individuals and communities. Travel restrictions imposed during the pandemic further complicated matters for firms that heavily rely on international markets, disrupting supply chains and impacting various industries. The multifaceted effects of the pandemic highlighted the need for resilience and adaptability in both professional and personal spheres.

The following quotes exemplify COVID-19's impact on the fashion industry during the first wave of the pandemic.

"Just like in every sector, we too experienced a shock effect. Suddenly, all our orders canceled because our customers also halted their production. Eventually, with their stoppage, the flow of orders ceased, and with our initial decision, for a certain period, we also stopped production just like every other sector." (Company 11)

All tiers of suppliers faced this challenge since companies did not know how much sales would be affected by these lockdowns and quarantines. Due to the nature of the industry, some of the selected companies, for instance, asked suppliers to stop their production process if there was a product that had yet to be cut in any way by taking responsibility for the fabric. Some brands just cancelled the orders without checking whether the fabric was cut or dyed, which caused severe problems for the suppliers.

"During the coronavirus period, I mean when the pandemic first started and there was a complete shutdown, everything stopped; we were incredibly negatively

impacted. Talking about the supply side, when sales stopped, it started a reverse effect. What can we stop, what can we cut in terms of financial management? However, we had problems with our yarn supply from the Far East, and our fabric supply completely stopped. The flow of all our products, especially those we import, from abroad completely stopped. We couldn't send many of the products to our 600 stores abroad that I mentioned."(Company 1)

Since a steady supply of materials like yarn and fabric is crucial to sustain production for fashion companies, the interviewee's statements highlight a dual challenge in the supply chain. On the inbound side, they faced disruptions in obtaining essential raw materials, leading to potential production halts. On the outbound side, they had issues distributing finished products to their international stores, likely leading to lost sales and a decrease in customer satisfaction. Such problems in both inbound and outbound flows highlight the vulnerabilities of global supply chains in the fashion industry, as in the company's example above. Furthermore, the same company illustrated the customs issues they have faced due to changing regulations as follows,

"Depending on the procedures of different countries, we had a lot of issues at customs. Because all distribution is actually done from Türkiye. As I said, we came to a point where we completely stopped production, our raw material purchases stopped, sales stopped, we couldn't dispatch products; in general, every negative thing you can think of affected all our channels, that's what I can say." (Company 1)

Additionally, a focal company further demonstrated the sudden and overwhelming disruptions they experienced with the COVID-19 pandemic in the following quote. This highlights one of the vulnerabilities in the fashion supply chain: the interdependence of operations, from raw materials to finished product deliveries.

"We can divide this into two time cycles: what we experienced from the moment we received the news, and what we experienced after we got over the initial shock. Imagine your customers one day saying, 'Stop production'. How? I mean, there are people working on machines right now, there are trucks on the road, there are fabrics to be loaded and delivered to warehouses, there are finished products. We can't just stop everything immediately. But the situation was exactly like that. Loadings stopped, systems were shut down. We couldn't log into computers. As you know, all these international brands have ERP systems. When you do your loadings, you get approval from that system, you enter everything about the loading, its quantity, warehouse, etc.,

and suddenly they tell you from the other side, 'Stop it now'. At that moment, frankly, we struggled a lot. Customers, as they stopped production,it was as if they also put life on hold. They stopped everything. Imagine such a scenario. That was the first part. Initially, we experienced that loss. We had to pull our products back to the warehouses. We had to withdraw our semi-finished fabrics from production. They also stopped the payments suddenly, and we couldn't get your money for a few months."(Company 3)

According to one of the global clothing retailer companies (Company 10), suppliers were especially concerned because of the social restrictions since retailers have the power to cancel their raw material orders in such situations. For instance, one of the interviewees from a cotton supplier company among the sample illustrated the difficulties they required to handle such demand shocks as follows,

"In this pandemic crisis, as you know, we first encountered a demand shock. Because the first crises started from there for us, we experienced a very serious demand crisis. Suddenly everything stopped. Before even getting to the supply, we were left hanging like that." (Company 19)

This demand shock further yielded a partnership crisis in the supply chain because of the financial issues. Prioritizing their interests over their partners eventually left manufacturers in a difficult position since the fashion industry relies heavily on trust and long-term relationships across its supply chain.

"What are we going to do in this demand crisis? "Now, when there is a demand crisis, unfortunately, it became apparent that the substance of many partnership and collaboration discussions was largely empty. I mean, at that moment, everyone looked out for themselves, and those who frequently emphasized sustainability, whom you'd call the most reliable, initially left the manufacturers in a very difficult situation. This, of course, put a huge financial pressure on the manufacturers' side, because what were the actions taken at first? Short-term thoughts like, 'Let's stop the orders', you can manage some finance with that. 'Let's cancel them', that became a big problem. Payments were stopped. I mean, you've invested your money, sold your products on credit. There were also problems in receiving that money. This time, financial difficulties started in the supply chain, among suppliers who already had small margin ratios and whose financial situations were never as strong as those of the major retail brands." (Company 19)

On the other hand, retailers among the sample also highlighted the challenges they have faced because of the lockdown requirements, such as stores being closed.

During the earlier phases of the pandemic, consumers cut down on spending on fashion clothing. They were inclined toward buying essential products rather than spending money on clothing items. While the ongoing decrease in demand made it difficult to control the supply and demand, the retail side was affected heavily after stores were closed for an unknown period, which is their primary source of income. This is mainly because almost all the clothing retailer companies stated that e-commerce was not their primary source of sales before the COVID-19 pandemic. One of the interviewees from a global clothing retailer illustrates this imbalance in supply and demand by the following:

"Now, at that time, there was no break in the chain or problem in supply yet. But when we closed the stores, the demand dropped to zero, so suddenly there was no demand. No demand, but the supply continued." (Company 5)

The COVID-19 pandemic outbreak was soon followed by its domino effect. It initiated a series of disruptions within the fashion supply chain, creating a domino effect, while each disturbance led to subsequent challenges in the fashion supply chain.

- ***Effects of COVID-19 on Consumer Behavior***

A shift in consumer behaviour towards comfort-oriented apparel and more online shopping has occurred due to the lockdowns and long hours spent at home. With the global lockdowns, consumers were forced to stay at home for long periods while spending less money, which made them prefer loungewear and comfort styles more via online channels. An interviewee from a garment manufacturer illustrates this as follows,

"For consumers continuing their everyday lives, there was a noticeable trend towards purchasing less. This decline was primarily due to the constraints of not being able to visit physical stores or carry on with normal daily life as before. However, we observed that people who adapted themselves to this situation began to change their wardrobes with increasing momentum. I mean because, with the work-from-home environment, they preferred comfortable yet stylish products, not just attending meetings in pajamas, but choosing comfortable yet fashionable items." (Company 8)

Consumers swapping style for comfort eventually forced companies to acknowledge this comfort dressing trend and adapt themselves by adding loungewear collections to their existing lines and extending their collections accordingly. While loungewear, homewear, and activewear collections started to gain more importance, consumers moved away from more formal wear.

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"Trends are changing. The biggest impact of Covid on us, particularly in the textile industry, was this shift in trends. Suddenly, there was a move from sparkly and formal clothes to lounge wear, home wear, and more casual, tracksuit-like qualities. Activewear and home wear volüme increased. As we wisely invested in activewear clothes during this period, we are now able to work with global giants in the activewear field. Therefore, our factory never stopped." (Company 22)

For instance, an interviewee from one of the focal companies mentioned the expenditure of a specific department, sleepwear collection, as follows;

"There was an extremely high demand. Certain departments experienced growth, particularly our pajama department. Why? People were staying at home, and the only thing they wore was pajamas; the only gifts they bought were also pajamas." (Company 9)

Along with the increased online shopping, to make up for the shopping experience missed due to the pandemic, consumers also started "revenge shopping" with the relaxed lockdowns. Therefore, consumption has increased again. One of the interviewees from a fabric supplier mentioned that by July 2020, they'd recovered from the loss of sales during the early phases of the pandemic and continued to sell even more. Not only fabric suppliers in the sample but also various garment manufacturers illustrated how consumers started spending more with the relaxed lockdown restrictions. The following quote demonstrates this increase in demand for clothing items as follows,

""At that time, the brands we worked with were among the leading retailers in the fast fashion. We saw a sudden and significant increase in demand for these brands. This was because people in Europe, who had been confined to their homes for about 2.5 to 3 months, began to go out in a controlled manner. As soon as these individuals, who had been unable to go outside, had the opportunity, they immediately indulged in consumption, leading to an incredible increase in demand." (Company 21)

"Our demand increased in an unusual manner, as we had ordered fewer products anticipating the pandemic. As a result, we experienced an extraordinary increase in demand, even breaking records.I think this could be because we are a sportswear brand, and people shifted from the rush of dressing up and going to the office daily to a more 'Now I work from home, then let's buy sweatpants' mindset. They focused on exercising more, thinking 'Let's start exercising, walking since I'm at home and can't go anywhere.' This shift to a freer and more comfortable fashion style was

extra beneficial for us, the sportswear side. Additionally, people probably got bored at home during these 2.5 years, continuing to work from home without much else to do, and they ended up focusing on buying clothes – 'Let's buy something, do something.'" (Company 20)

As mentioned above, COVID-19 has changed the shopping behaviours of individuals, consequently affecting various players in fashion. Despite the relaxation of lockdown restrictions, because of the increased in-store purchasing concerns, consumers still avoided visiting physical stores, especially during the early phases of the pandemic. However, due to the long hours spent at home, customers shifted towards comfort clothing shopping via online channels, which eventually caused an increase in online demand. To manage such a demand shift, brands focused on e-commerce more. Nike, for instance, reacted to the shifting consumer behaviour, necessitating a pivot towards athleisure and digital sales channels. However, the sudden increase in online orders revealed another fashion supply chain vulnerability: the challenge in shipping operations, which caused delays in product deliveries and replenishment. The increase in online shopping during the pandemic disrupted fashion supply chains' distribution strategies. E-commerce giants like Amazon and Alibaba faced challenges in managing the increase in online orders, leading to potential delays in delivering fashion products to consumers. Brands had to rapidly adjust their supply chains to prioritize e-commerce channels, optimize warehouse operations, and ensure seamless online order fulfilment. As more consumers shopped online, one of the interviewees from a global clothing retailer also mentioned the increase in their staff by ten times with this growing demand for online shopping.

Consequently, fashion retailers' risk perception changed for brick-and-mortar store inventories, as the following quotes demonstrate, the impact of stores being closed on their production capacities and sales,

"The shutdown of both the manufacturers and the stores of our customers led to a general decrease in capacity. Compared to the previous year, there was a drop during the months when the effects of the pandemic were felt. But a year later, in the same months, the decline returned to standard levels. We are currently very cautious about the products sold in the store chains, as the stores can always face a drop in sales due to potential lockdown decisions." (Company 13)

An interviewee from a supplier company highlighted an important fact: because of the stores being closed for an unknown period due to the lockdowns,

companies started to decrease the number of collections in physical stores. For instance, according to the same interviewee, the model and option numbers in the stores dropped from ten to seven, forcing them to adapt their production planning immediately to this new situation. Even when lockdown restrictions were relaxed and physical stores were open again, consumers still avoided or limited visiting physical stores. While the tactile experiences offered by physical stores, particularly touching and feeling the product's fabric, are essential shopping experiences, concerns over catching or spreading the disease while shopping and trying on clothing have impacted retailers directly.

- ***Effects of COVID-19 on Distribution Channels***

The sudden changes in consumer purchasing behaviour during the pandemic caused an unpredicted demand, eventually yielding a bullwhip effect. The bullwhip effect has occurred as a major issue in the fashion supply chain, which is caused by several reasons, such as demand forecast updates, order batching, price fluctuations and shortage gaming (Lee, Padmanabhan, and Whang, 1997). Moreover, such demand fluctuations cause additional costs and longer lead times. Not only because of this unpredicted demand but also due to different lockdown restrictions among nations, the fashion supply chain has been affected globally. This is mainly because fashion supply chains generally involve many different individuals at all levels of production; therefore, it is also challenging to keep track of where parts of the products originate. Consequently, managing this complex supply chain in such volatile environments is extremely difficult. An interviewee from a trade firm illustrates its impact on lead times as follows;

"I, for instance, buy fabric from Italy, I mean, I facilitate its procurement. However, the yarn for this fabric comes from China, or from some other place. The label, 'Made in Italy' doesn't always mean it was entirely produced in Italy. So, there have been delays in timelines. This is related to a complete global supply network, and there's still an ongoing serious disruption." (Company 24)

Along with the fashion supply chain being really complex, China, the world's largest exporter, having a zero-covid policy, sent severe shocks through the global supply chains. The following quote from an interviewee from a global yarn manufacturer demonstrates the increase in the lead time of raw materials supplied from China.

"Supply issues began, especially with the outbreak starting in China. When we

stopped in April, we also postponed the orders with our Far East suppliers, as we weren't manufacturing and there was no consumption. The issues that arose in the China also impacted us when we started placing orders. We began facing difficulties in receiving goods when we needed them, delays started to occur. The effects of coronavirus definitely had an impact; our production dropped, and disruptions occurred in the supply chain. The bullwhip effect inevitably happened to us too. The effect at one stage in China was amplified three to four times by the time it reached us." (Company 11)

Similarly, another interviewee from a garment manufacturer mentioned this bullwhip effect on their synthetic fiber supplies after a year. The following quote illustrates this,

"Of course, the halt in production and the fact that some raw materials were not produced, like in China, especially looking at 2020, there was a 68% rate of synthetic raw materials in textile raw materials. A large part of this, maybe more than 40%, is produced in China, then it turns into yarn, then into textile products. Delays in the production of many raw materials will affect the next year, hence we had raw material issues a year later, particularly problems with synthetics from China." (Company 8)

This is mainly because raw material production was also slowed down during the earlier phases of the pandemic. But, after the relaxation of the lockdown restrictions, companies rushed to replenish their stocks which eventually led to a global shortage of raw materials as well as an increase in prices. Findings revealed that, from the supplier side, the main challenge they have experienced was the difficulties encountered in finding raw materials, including cotton, fiber and colourants. For instance, an interviewee from a semi-processed material supplier illustrates COVID-19's impact on sustainability awareness, which eventually affected the fashion supply chain as follows,

"With the COVID-19 pandemic, all brands were forced to create their sustainability manifestos due to increased public awareness. This time, everyone started demanding organic cotton. Again, due to insufficient resources, this process became problematic. There were significant issues with Tencel fiber. The demand increased, but there wasn't enough fiber production to meet it. I mean, managing this wasn't easy; there was a period when we couldn't find dyestuff. Thankfully, we had stock, but there was a time when there was no dysestuff available." (Company 22)

A garment manufacturing company has also experienced the same challenge of finding raw materials from their supply chain partners from the Far East, such as China, Bangladesh, Vietnam, India etc. While one reason for this is the Asia-Pacific region's global dominance in the fashion industry since such countries are the largest garment exporters in the fashion supply chain, Türkiye's lack of resources is another issue revealed in the findings of this thesis. When the existing raw material stocks diminished with the increased demand, their supply chain became disrupted. The following quotes exemplify this.

"When the raw materials began to run out, when stocks in Türkiye started depleting, and the supply chains in Asia and the Far East broke down, that's when we began to feel it. Then we started to notice cost increases and extensions in delivery times." (Company 21)

Although cotton production exists in Türkiye, the interviewees mentioned that it is not possible to use 100% of it because the production volume is not enough in Türkiye. Most of the raw materials are exported products forcing companies to export rather than utilize domestic products.

"If all production was domestic, including raw materials, Türkiye would have had a completely different export revenue. That's the problem. It's a problem for all sectors in Türkiye, the majority of raw materials being imported." (Company 8)

Another impact of COVID-19 on reaching raw materials is the decrease in cotton planting, according to an interviewee from a garment manufacturer. Since cotton fields were not planted during the pandemic, cotton harvest was less than expected. Accordingly, cotton prices increased as expected.

"Cotton prices started to increase. But after May, both the supply and the price of cotton became problematic. The prices increased, and the supply of cotton also encountered difficulties. On the other hand, just when we thought, "Could this situation get better?' the supply of cotton still wasn't enough. Now, cotton prices are continuing to increase." (Company 5)

The fluctuations in raw material prices, as well as the volatility of the Turkish Lira, made it difficult for almost all companies to deal with the costs of raw materials. The following quote illustrates this.

"With the pandemic, cotton prices began to increase due to demand. When the demand increased, a crisis occurred suddenly. Then, rumors started spreading that 'it's decreasing,' and immediately prices began to rise. We started taking daily prices,

and even hourly prices. The price of fabric I got in the morning could be different in the afternoon. 'How much is this fabric? This much.' 'Okay, get the yarn for it now.' If you didn't get the yarn, it could be more expensive to produce the next day. Now, with the influence of the dollar, for instance, a pajama set that was 49.99 last year is now 99.99, and this price is about to reach around 130 lira due to the exchange rate." (Company 9)

As the above quote illustrates, this increase in cotton prices as well as Turkish Lira's drop in value, eventually caused a rise in the prices of fabrics. The same interviewee further demonstrated that there was a price increase of up to 4 times in a year and a half. A trade firm further illustrates this as follows,

"There were major problems and delays in the supply of yarn, especially imported yarns. And did they arrive in the desired quantity? No, they didn't. Since they didn't arrive in the desired quantity, this caused an increase in prices. The same with the rise in raw material prices. In Türkiye, exporters, I'm speaking in terms of TL, they don't make purchase in TL. They make their purchases in dollars, so they faced increases in dollar terms as well. We had a lot of trouble in this regard. Our problems in supply, as I said, are due to raw material issues. What did this lead to? It led to situations like not being able to take some large orders, because there was no yarn or the yarn's lead time was too long. As I said, since it's imported yarn, it took a long time to bring it here. So, we experienced order losses due to these reasons, and that was the biggest issue." (Company 13)

Moreover, growing awareness of environmental concerns has intensified the fashion industry's focus on sustainable practices, leading to disruptions in traditional supply chain models as brands adopt eco-friendly materials and ethical production processes. The pandemic-induced domino effect in the fashion supply chain showed the multifaceted nature of the fashion industry's interdependencies and manifested the interconnectedness of various tiers within the supply chain. (Vogue Business, Just Style)

- *Effects of COVID-19 on the Labor Force*

After employees started to catch the disease, the quarantine requirements immediately caused workforce loss, and all operational activities were directly affected by the spread of the virus. Moreover, in addition to the challenges in the fast-changing nature of the fashion industry, the swift adjustments in quarantine regulations eventually posed significant difficulties in meeting their delivery timelines.

"I mean, it had a significant impact, frankly. The emergence of two COVID cases and the tendency at that time to shut everything down... Later, this approach shifted to isolating only the contacts and sending them for testing, and quarantining them accordingly. But initially, we faced problems with small workshops being closed down as soon as one or two cases were detected. This disrupted our supply chain. Lead times were significantly extended. As you know, seasons in the textile industry have shifted significantly, with much shorter lead times. There were times when we could only get the raw material in 7 weeks for products that needed to be in stores within that period. These were critical times."(Company 8)

Some of the companies quickly adapted themselves to the new working-from-home dynamics to prevent the spread of the virus; however, an interviewee from one of the garment manufacturers stated the *psychological and physical side effects of COVID-19* as follows;

"We even experienced the loss of our key personnel temporarily. They either had long quarantine periods or were physically and psychologically affected. They hesitated to enter the facility, etc. For example, in textile production, there are processes that cannot be automated or digitized – what we call the 'touch feel' processes. Experts in these areas make decisions on new treatments based on touch. For instance, one such person, a severe diabetic, had to be kept at home for protection, causing delays in our operations." (Company 8)

In the fashion industry, the tactile quality of fabrics is pivotal, and human experts are essential for evaluating and deciding on this aspect, as it cannot be fully automated or digitized. These experts use their touch to guide crucial production decisions. Because if an expert is responsible for deciding on a specific treatment or modification based on the tactile quality of the fabric, their absence, as highlighted in the quote, can delay production or decision-making, potentially affecting product quality or delivery timelines.

- *Effects of COVID-19 on Logistics Operations*

Similarly, another challenge that the interviewees mention is the *logistics side effects* due to drivers' health and quarantine issues, such as the long isolation times of the long-haul truck drivers. The different lockdown restrictions among nations caused not only operational difficulties but also financially impacted them as well. This eventually led to difficulties in logistical operations. For instance, an interviewee from a trading firm mentioned that the arrival times of the ships from India to Türkiye

(Gaziantep) have increased from 10 days to 60 days, which caused massive disruption to their operations.

Although the transportation and logistics sectors had to continue operating despite the pandemic, logistics activities were affected negatively, eventually causing an increase in logistics costs. Similarly, another interviewee from a yarn manufacturer stated that such logistical disruptions not only caused delays and costs but also it eventually induced border closures or jams at customs. An interviewee from a raw material supplier exemplifies their logistics operations challenges as follows,

"The biggest disruption was in logistics. The issues in logistics were incredibly severe. Normally, we were more comfortable with logistics in terms of cost and transportation time, but we faced significant problems after the pandemic. Costs increased substantially, causing a lot of trouble in terms of transportation and logistics." (Company 13)

Moreover, another interviewee from a global clothing retailer explained how such supply chain operations became more costly with the pandemic as follows.

"For example, I can tell you that there's a huge difference between my initial model's shipping cost and the cost after COVID-19. The volume of shipments is unbelievable. Especially if you are new in the market and don't have a certain volume, you can't achieve price advantages. There was a significant difference between the price I paid when I established my model and the prices one year after the pandemic. I mean, shipping costs increased significantly. Now, as more shipping companies emerge, prices are dropping due to competition. But initially, because people were just sitting at home and everything was dependent on couriers, couriers became very valuable. It affected my logistics side and significantly increased my costs. That was one of the impacts of COVID-19, frankly." (Company 6)

- *Effects of COVID-19 on Financial Performance*

The expert interview findings were then analyzed based on COVID-19's impacts on companies' financial performance. The findings revealed that, while some of the impacts of COVID-19 caused negative financial consequences such as lost sales, additional warehouse expenses, and increased expenses of long-haul truck drivers, there also exists various positive financial effects too such as increased turnover and lower inventory costs. Particularly during the early phases of COVID-19, to cope with the volatility in the demand, some of the companies canceled, and some postponed the orders which caused severe disruptions in the supply chain. Although the demand

towards fashion clothing started to increase eventually, particularly after lockdown relaxations, financial consequences of the lost sales is demonstrated by a global clothing retailer as follows,

"When we look at the year as a whole, our turnover or sales remained very low. We had to meet a huge demand in a very short period. We couldn't stock up because we didn't know what would happen. Even though we had a very busy summer, we couldn't even come close to the sales and turnover of other years." (Company 12)

In the fashion industry, being able to predict trends, manage stock efficiently, and respond quickly to market demands is crucial. Such mismatch between supply and demand or being unprepared for a change in demand can significantly impact revenues and fashion industry's seasonal nature further amplifies these challenges. Moreover, the inability to hold stock due to such unpredictable disruptions can lead to a negative impact on revenues, further complicating cash flow management. Such challenges can significantly affect profitability, as the company might have fixed costs to cover regardless of sales volume, and missed sales opportunities directly impact the bottom line. In such disruptions, while some companies canceled the orders directly, others became more flexible in terms of due dates and credits in the supply chain by focusing on cash flow more. Following quote exemplifies this

"Profitability has become more important than turnover now. We are trying to manage the system based on cash flow. We are trying to be more flexible in terms of payment terms. The customer has also become more flexible in this regard. All manufacturers are trying to manage this properly within their own operations." (Company 7)

In the meantime, companies' expenses have been increased such as expenses related to COVID-19 precautions and long-haul truck drivers' accommodation. For instance, one of the global clothing retailers mentioned the financial consequences of isolation and quarantine requirements of the long-haul truck drivers as follows,

"For example, as exporters, we work with transport companies that take our products abroad. We have rules like being prioritized in agreements or being a priority in airways. We have been paying for years to avoid that risk. We saw its advantages, but of course, prices increased. For example, costs in the supply chain, especially for truck drivers, increased. When truck drivers went to another country, they had to quarantine there and again when they returned to Türkiye. If a driver made one trip, he was almost on the move for 20 days, 10 days there and 10 days here. This created

a significant gap compared to the number of vehicles and drivers. That gap still exists and has likely increased our costs financially." (Company 4)

On the other hand, both cotton suppliers among the selected companies mentioned the positive influence of increased raw material prices by the sudden increase in cotton demand. Surprisingly, another interviewee from one of the global clothing retailers exemplified the positive financial impact of this ongoing demand increase by lowering their inventory levels. By reducing stock purchases, they not only managed to avoid potential overstock situations but also freed up cash, making their operations leaner and more efficient.

"Interestingly, we were positively affected financially. Here's how: there's a metric that global companies look at called 'working capital.' We were a bit negative in that. The company was always using financing to keep running. But during this period, as we reduced the quantities of stock and product purchases, our finances became more efficient and sustainable. Our finances turned positive. The company started generating cash surplus from its operations. So, financially, we were positively affected." (Company 20)

A negative working capital, as previously experienced by the above company, suggests that the company might struggle to meet short-term liabilities with its short-term assets. By decreasing their stock purchases and likely benefiting from less short-term liabilities due to fewer stock obligations, the company was able to improve its working capital position. This shift from negative to positive working capital indicates a better liquidity position, meaning the company can more easily cover its short-term debts, leading to a more sustainable financial stance and a reduced reliance on external financing.

In addition to COVID-19 pandemic, between 2019 and 2023, the fashion supply chains faced a series of other disruptive events including the Suez Canal Blockage, the Xinjiang cotton ban, geopolitical tensions such as the Russia-Ukraine war affecting material sourcing, wildfires and natural disasters impacting material availability, and the global energy crisis causing supply chain disruptions and cost increases.

Suez Canal Blockage

The grounding of the Ever Given ship in the Suez Canal, a crucial maritime route connecting Asia and Europe, in March 2021, emerged as a focal disruption in the fashion supply chain, causing delays and bottlenecks in the movement of goods.

This disruptive event exposed one of the vulnerabilities in the fashion supply chain, that is, the fragile nature of major trade routes as in the Suez Canal example. Following quote demonstrates the impact of Suez Canal blockage on their operations.

"For instance, the shipwreck in the Suez Canal caused us a major problem. As it was sea freight, the closure of the Suez Canal resulted in delays of about 1 month, 40 days at sea. This negatively affected our customers, of course. It showed that not only through sea but also, as we all experienced, a single accident in the Suez Canal caused major disruptions. In sea transportation, increasing rail transportation would have been positive for everyone." (Company 14)

As pointed out above a blockage like this may cause a domino effect, disrupting not just the directly affected routes but also other connected shipping lines causing challenges in movement of goods, affecting companies globally. For instance, fast fashion companies like Zara, heavily reliant on just-in-time production and inventory management, faced tangible challenges. The inability to receive timely inventory prevented them from meeting consumer demand, leading to lost sales opportunities. Moreover, luxury fashion house Chanel also faced delays in receiving imported fabrics from Asia due to the blockage. This disruption emphasized the necessity of building resilience in terms of reevaluating the logistical strategies such as diversifying transportation routes in order to ensure the uninterrupted flow of goods and building collaboration across the supply chain to navigate the challenges posed by such disruptive events.

Additionally, the news content analysis findings also revealed that, The Ever Given cargo ship's six-day blockage in the Suez Canal raises significant supply chain concerns for the European garment sector. Although spring-summer collections have been secured, the availability of containers for the autumn-winter collections shipping from Asia in May is uncertain due to expected port congestion in Europe. With the garment industry already challenged by the pandemic, companies may face further transport cost increases and resort to pricier air freight options to prevent stock-outs. The blockage's long-term impact on global logistics capacity and freight costs remains unclear, with no evident shift in sourcing strategies for European brands in response to the crisis (Just Style).

After the Suez Canal Blockage, the closure of key ports, such as the Yantian port in China, added complexity by congesting ports and disrupting cargo flow. These incidents resulted in delays in transporting raw materials and finished products,

subsequently affecting inventory levels and leading to distribution bottlenecks. Consequently, brands had to deal with not only the delays but also with rising freight costs caused by reduced container availability. As shipping rates increased, the increased transportation expenses added to supply chain costs, impacting overall profitability for fashion companies.

Xinjiang Cotton Ban

Simultaneously, the Xinjiang cotton ban raised ethical questions on sourcing practices. Driven by concerns over forced labor in Xinjiang, China, bans on cotton produced in the region. resonated deeply within the fashion supply chain, as cotton is a pivotal raw material. This disruptive event caused fashion brands to search for alternative sources of cotton, impacting their production timelines. The following quotes exemplifies this,

"The ban on organic cotton from China had a big impact... We actually never used cotton from China or India. But following the Uighur Turks issue in China and due to issues with organics in India leading to a ban, the whole world rushed to the suppliers we were using." (Company 22)

"We are affected by the supply crisis in China or other countries because there are models produced specifically in those countries. Consequently, we are experiencing delays in the sales and shelving of those models." (Company 4)

Furthermore, according to one of the articles from our news content analysis, brands like H&M encountered boycotts and consumer backlash causing both operational and reputational damage. Human rights groups allege that Xinjiang cotton, which constitutes 20% of the global supply, is harvested using forced labor by the Uighur minority. The complex supply chains make it difficult to trace the cotton's origin in consumer products. Although China denies these claims, Western brands expressing concerns are facing boycotts within the country (BBC News). Consequently, to comply with the ethical standards, companies started to reevaluate their sourcing strategies. This has fueled a move towards nearshoring and "conscious capitalism," emphasizing local, ethical, and quality over quantity. Inflation has resulted, suggesting products have been undervalued for years, often at the cost of human rights (Suply Chain Brain). While this disruptive event highlighted the importance of responsible sourcing, it also prompted the necessity for transparency across the supply chain. Beyond H&M, sportswear brand New Balance also had to reassess its supply chain to ensure that its apparel products were free from Xinjiang

cotton. This required identifying alternative cotton sources and potentially revising product designs to accommodate the use of different materials.

Russia-Ukraine War

The Russia-Ukraine war introduced geopolitical tension into the fashion supply chain while highlighting the vulnerabilities of supply chains dependent on specific regions. Fashion brands that source materials or manufacture products in Eastern Europe faced potential disruptions in their supply chains. Fast fashion retailers Uniqlo and Forever 21, luxury brands such as Burberry and Louis Vuitton, reliant on specific regions for materials, confronted sourcing challenges due to political uncertainties. An interviewee from a fabric supplier demonstrates the ongoing impacts of Russia-Ukraine was as follows,

"I can show you last year's contract, for example; we used to bring a roll for 12 TL, now it's 58 TL. That should say enough about the price, right? Operationally, the pandemic didn't affect me much, as we are an export company with work permits. It didn't harm me that much, but currently, the crisis in Russia is affecting me more." *(Company 25)*

Findings of the news content analysis also revealed that the Russia-Ukraine tensions have made it necessary for fashion companies to diversify suppliers, potentially leading to increased costs and longer lead times in their supply chain. but also signified a strategic recalibration in the face of uncertain geopolitical dynamics. This disruption forced companies to consider the geopolitical landscape as a critical factor in sourcing decisions, prompting strategic diversification of suppliers and risk mitigation strategies (Just Style)

Economic Instabilities

In addition to these disruptions, global economic instabilities, and fluctuations, along with rising inflation rates, create an uncertain business environment for the fashion industry too. Turkish Lira had been declining in value against other major currencies, leading to increased costs for imported goods. Volatility in the currency made pricing highly unpredictable at every stage of the supply chain. Constant price recalculations at every level from yarn to dyeing, from raw materials to final products then impacted financial planning, risk assessment, and ultimately, profit margins of companies. Following quote exemplifies this,

"The fluctuations in exchange rates continued. Our country was unfortunately more affected, increasing its vulnerability. This directly impacted the manufacturers.

The suppliers, the companies that had previously purchased raw materials, were greatly affected." (Company 8)

As the value of the Turkish Lira declined, the cost of importing energy resources like natural gas and oil, which are mostly priced in foreign currencies escalated quickly as well, leading to increased energy costs.

"Electricity costs are our biggest expense after raw materials in the production. Our electricity bill has increased by 450% compared to December 2020. This is actually a terrifying figure, 450%." (Company 23)

Escalating energy costs eventually caused higher transportation expenses, adding to supply chain costs. Suppliers in garment-producing countries like Bangladesh have faced economic hardships due to reduced orders from fashion brands. This strain on suppliers has led to potential delays in material delivery and quality issues for brands like H&M. Such economic instabilities have led to reduced hiring in the fashion manufacturing sector too. Retailers such as Gap and Primark had to navigate labor shortages in certain regions, impacting production timelines and potentially affecting the availability of their products. Simultaneously, raw material scarcity, symbolized by cotton and polyester interruptions, increased cost pressures. In addition to the interview findings, the news content analysis also supported this with the following example. H&M's experience with cotton prices shows how these challenges resulted in financial constraints and necessitated adjustments in pricing strategies. Fluctuations in cotton prices have led to challenges too for brands like Levi's. Sudden increases in cotton costs impacted production costs and pricing strategies, potentially affecting brand profitability. For instance, Nike reported lower profit margins due to increased manufacturing and shipping costs caused by inflation, prompting them to explore cost-saving measures (Reuters).

Furthermore, high inflation rates and economic uncertainties have led to decreased consumer spending on fashion items. Luxury fashion brands like Gucci have experienced reduced demand for high-end products as consumers prioritize essential goods and cut back on discretionary spending. Luxury fashion brands Burberry and Chanel have adjusted their marketing strategies to appeal to cost-conscious consumers. They've introduced more accessible product lines to adapt themselves to changing consumer preferences influenced by economic uncertainties. On the other hand, economic uncertainties have disrupted demand forecasting for fashion brands too. For instance, Gap faced overstocking issues when consumer demand fell below

expectations, leading to excess inventory and potential losses.

Labor Shortages & Strikes

Labor shortages and strikes disrupted production processes, led to delivery delays, and spotlighted ethical considerations related to worker rights. Labor shortages in certain regions due to factors like COVID-19 restrictions and worker migration, as well as worker strikes, disrupted manufacturing, and impact production timelines. In countries where garments are often produced, like Bangladesh and Vietnam, there were instances of not having enough skilled workers to meet the industry's demands. This led to difficulties in meeting production targets, delayed deliveries, and an overall disruption of the supply chain. For example, companies like H&M faced delays in receiving orders due to labor shortages in their production hubs. Among the selected sample, one of the leader clothing retailer companies mentioned the challenges they have encountered with the worker strike in Spain as follows,

"During the strike in Spain, the ship carrying products we wanted to send to our stores in the Africa region got stuck in customs there for an indefinite period. Because our planned products didn't arrive in our stores on time, we started to lose money directly. We have departments trying to contact someone about this, dealing with such external relations. But frankly, there is no reliable information from either our own government or from there, it's unclear when it will be resolved. We couldn't take any action, we just waited helplessly and lost sales during that period. Some products missed their season." (Company 1)

Additionally, according to an article from the news gathered and analyzed, workers, demanding better wages and improved working conditions, engaged in strikes that disrupted production processes. These strikes disrupted the production flow and led to bottlenecks in the supply chain. For instance, in 2019 strikes in Bangladesh, garment workers protested for higher wages and safer working conditions, resulting in production slowdowns and delivery delays. UK-based retailer Topshop experienced production delays due to labor strikes in its primary manufacturing country, Bangladesh. The delays affected the delivery of new fashion collections to their stores and led to missed sales opportunities.

While the challenges brought about by labor disruptions exposed vulnerabilities in the fashion supply chain, it also highlighted the importance of fair labor practices, ethical sourcing, and collaborative efforts to ensure a more resilient and socially responsible fashion supply chain. Labor shortages and strikes highlighted

the complex interdependence between workers, factories, and the broader fashion supply chain. Brands had to manage not only the immediate challenges of production delays but also the ethical considerations tied to fair labor practices. Many companies engaged in dialogue with labor unions and initiated efforts to improve worker conditions and wages to address these issues.

Global Warming and Wildfires

Unfortunately, global wildfires, an ongoing environmental challenge, extended their impact to the fashion supply chain in recent years. They disrupted raw material sourcing in the fashion supply chain. The wildfires in California disrupted logistics and production schedules for fashion brands such as Gap. The need to ensure the safety of workers and navigate transportation challenges led to delays in receiving products and fulfilling orders. Additionally, wildfires in Australia impacted the availability of wool, a key material for the fashion industry. Brands like Cotton On faced wool shortages due to Australian wildfires. Moreover, Turkish wildfires in 2021 also had devastating effects on various sectors, including the fashion supply chain. As following interviewee from a garment manufacturer illustrates,

"Of course, we were affected by the wildfires, because I have many customers in the southern parts like Bodrum-Antalya. For example, deliveries are delayed by 3 to 5 days. People are sensitive because it's a monthly package. They want it immediately, they want to use it. There will always be problems. I never dream of a flawless operation nor do I strive for it, but it's important to find solutions to problems. When such a delay occurs, the biggest area where I suffer is timing and shipping related to global disruptions. In such cases, I either open an extra spot or extend the time to satisfy the customer. I'm at a level where I can communicate directly with my customers. We have a policy developed to cover them entirely, but it's very individualized." (Company 6)

This disruption also emphasizes the relation between climate volatility and supply chain vulnerabilities, leading discussions to climate change. While climate change is not one of the highly mentioned issues among the interviewees, the news content analysis findings revealed that fashion industry is adjusting to climate change, which has led to warmer winters, affecting sales of traditional winter clothing. Retailers like Uniqlo, H&M, and Gap have announced major seasonal shortfalls, with Macy's cutting jobs due to decreased sales of cold-weather goods. As a response, some brands are reconsidering their long lead times and seasonal scheduling to better align

with actual weather patterns and consumer needs. For example, limited-run clothing, produced closer to the season, and in-season fashion shows are emerging as strategies to address climate-induced demand fluctuations. Additionally, there's a shift towards designing clothes with medium-weight materials and trans-seasonal fashion, reducing reliance on heavy winter garments. These changes reflect a significant departure from traditional fashion seasons and necessitate creative adaptations in both clothing design and business models to navigate the industry's climate-changed future (Fast Company). Moreover, Climate change significantly impacts water-intensive cotton production. The sector, emitting 1.3 billion tons of CO_2 equivalent annually, faces challenges with the rise of fast fashion, which increases waste with 60% of clothes discarded within a year. The industry's annual loss is estimated at USD 500 billion due to underutilized clothing. Transitioning towards sustainable practices, like 'slow fashion' and adopting a circular economy approach, is crucial for mitigating environmental impacts and promoting sustainability in the fashion industry (OEcotextiles).

6.2. Supply Chain Capabilities

Many interviewees asserted the fact that in the fashion industry particularly, demand is going to get more scattered than it was, and supply would be more disruptive than it used to be. Therefore, companies need to understand their vulnerabilities and capabilities to prevent such disruptions and develop strategies to build resilient supply chains. Findings demonstrated the importance of supply chain capabilities towards staying resilient during an external shock of high impact and low probability such as the recent pandemic outbreak. The interviewees affirmed that visibility in information sharing, trust among the partners, and digital transformation plays a key role in becoming resilient. The most frequently mentioned capabilities were revealed as 'flexibility', 'collaboration', 'digital transformation' and 'visibility'. Table 13 includes the supply chain capabilities of the sample companies.

Table 23. Supply Chain Capabilities of the Selected Companies

	visibility	supply chain reconfiguration	digital transformation capabilities	collaboration	financial capability	agility	flexibility	health & safety management	risk orientation	sustainability
Company 1	0	0	1	0	0	1	0	0	0	0
Company 2	0	0	0	1	0	0	0	0	0	0
Company 3	0	0	0	0	0	0	1	0	0	0
Company 4	1	0	0	1	0	0	1	0	0	0
Company 5	1	0	0	0	0	1	0	0	0	0
Company 6	0	0	0	1	0	0	0	0	0	1
Company 7	0	1	1	1	0	0	1	1	0	0
Company 8	0	0	1	1	1	1	1	0	0	1
Company 9	1	0	1	1	0	1	1	0	1	0
Company 10	1	0	1	1	0	1	1	0	1	0
Company 11	0	0	0	0	0	0	0	0	0	0
Company 12	1	1	1	0	0	0	1	0	0	0
Company 13	1	0	0	1	0	0	1	0	0	1
Company 14	1	0	1	1	0	1	1	0	0	0
Company 15	0	0	0	0	0	1	1	0	0	0
Company 16	1	1	1	1	0	1	0	0	0	0
Company 17	1	0	1	1	0	1	1	1	0	0
Company 18	1	0	1	1	0	0	0	0	0	0
Company 19	0	0	0	0	0	0	0	0	0	0
Company 20	1	1	1	1	0	0	1	0	0	0
Company 21	1	0	1	0	1	0	1	0	1	0
Company 22	0	0	0	0	1	0	1	0	0	0
Company 23	1	0	1	1	0	1	0	0	0	0
Company 24	1	1	1	1	0	1	1	0	1	1
Company 25	0	0	1	1	0	1	1	0	0	1

Agility

While scholars heavily use agility and adaptability antecedents interchangeably, in this thesis, they are analyzed as two different capabilities. Both supply chain agility and adaptability focus on the importance of flexibility when dealing with shifts in the supply chain and broader market. Yet, as highlighted in studies by Yusuf, Sarhadi, and Gunasekaran (1999) and Swafford, Ghosh, and Murthy (2008), agility particularly prioritizes rapid reactions to short-term changes while adaptability is the capability of responding to long-term changes, as noted by Tuominen, Kitaygorodskaya, and Helo (2008). In this regard, agility is defined as

"*the ability of the firm to sense short-term, temporary changes in the supply chain and market environment (e.g. demand fluctuations, supply disruptions, changes in suppliers' delivery times), and to rapidly and flexibly respond to those changes with the existing supply chain (e.g. reducing replacement times of materials, reducing manufacturing throughput times, adjusting delivery capacities)* (Eckstein et al., 2015, p.2).

In this thesis, agility is considered as the ability of the supply chain to rapidly respond and adapt to changing fashion trends, consumer demands, and disruptive events.

Nevertheless, agility has been discussed within two primary dimensions: *operational* and *managerial*. Operational agility, as explored by Swafford, Ghosh, and Murthy (2006), focuses on a firm's capability to quickly adapt themselves to disruptions in the operational environment such as reallocating resources as a response to demand fluctuations. On the other hand, managerial or strategic agility, as discussed by Sharifi and Zhang (1999), encompasses the foresight and responsiveness of an organization's leadership. It denotes the capability to identify macro-level shifts in the business landscape, reconfigure organizational strategy, and realign the supply chain resources. There also exist other agility dimensions suggested by scholars. For instance, Lin, Chiu and Tseng (2006) introduced the idea of *market agility*, emphasizing the rapid recognition and adaptation to evolving market dynamics or shifts in customer preferences.

Operational agility: Among the selected companies, six of them mentioned operational agility, to manage this supply crisis. Particularly, one of the interviewees

mentioned that, they made use of uncut materials by producing facial masks not to waste any raw fabrics. This eventually helped them to utilize the workforce and on-hand inventory for a good cause and made them the first mask manufacturer in Türkiye.

"Those companies that quickly integrated the production of hygiene products, non-woven products, disposable items, protective clothing, gloves, and masks into their production lines were able to swiftly fill the gap. They even achieved higher turnover than expected." (Company 13)

For instance, one of the manufacturers mentioned how they responded to the quickly changing environment during COVID-19 because of their focus on subcontractors. Working with subcontractors allowed them to flex their operations, even stop production in some cases during the pandemic. This eventually yields agility in terms of quickly adapting themselves to decreasing demand.

"Since we are focused on outsourcing, in such situations, we can completely stop our production like cutting it with a knife. You can stop production all of a sudden and just continue with what's already in progress. We saw our ability to be agile during the pandemic." (Company 1)

While this allowed the manufacturer firm to build resilience, subcontractors faced several challenges financially due to such pauses in production and even cancellations in the orders. Furthermore, to achieve agility another company mentioned that they need to skip some parts of their production process that is the quality control and assurance.

"In such a situation, since speed is crucial, some processes were skipped. For example, some fabrics were sent directly to Izmir for shipping without going through the usual quality control center. This meant deviating from the normal defined processes, which also carried certain risks." (Company 16)

Market Agility: Considering the fashion industry's highly volatile and rapidly changing dynamics, being responsive to market needs in such a changing environment is crucial for companies to survive. In addition to this complex global environment, ever increasing disruptive events occurring in the global supply chain forced companies to meet the growing market demands very quickly, which means being agile.

"So, when I think about it, agility becomes the key issue here. Fast adaptation and not resisting change are crucial. But uncertainty has become the norm in the

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current system. Everyone is now ready for anything at any moment, and this kind of agility has started to develop internally." (Company 9)

Moreover, with Türkiye's growing importance in the textile industry, being agile became more important than ever. One of the interesting comments on this topic was the high frequency of economic crises happening in Türkiye and how Turkish companies become agile to such changes through the years.

"We have always lived with crises in Türkiye, so we are naturally 'Agile'. That's why we were able to adapt quickly to this situation." (Company 22)

Managerial Agility: To cope with such changes in demand and adapt itself to constantly evolving business requirement, agility throughout the organization became important to build resilient supply chains as the following quote demonstrates,

"In order to take quicker actions, we are in a period that requires management agility. You need to act quickly, and given the scale of your organization, you must ensure that the action taken spreads rapidly to every part of the organization, even to the very end of it, to guarantee that the action is implemented at every point." (Company 3)

Health & Safety Management

With the COVID-19 pandemic, the term 'safety' has been redefined as well. Firms have recognized the need to prioritize both the health and safety of their workforce and the end consumers to build resilience. Companies have introduced rigorous health checks, temperature scans, and sanitation processes, especially in factories and warehouses. Many firms have reduced physical contact by transitioning tasks online and integrating digital tools for virtual collaboration. For instance, remote work conditions allowed them to ensure their worker's health which directly affects the performance and well-being of their staff.

"When the pandemic started, we sat down and formed committees. Occupational physicians, our own company doctor, production managers, sustainability experts, all of us together set up a procedure in such a committee and said, 'We need to integrate this very quickly into our businesses.' If we hadn't established our counterparts at our main center in time, it would have taken us much longer and been much harder to take these actions today. In the period when COVID-19 cases were rising rapidly, we managed this very well in 70 to 80 percent of our businesses. We managed the process well without leading to large-scale quarantines or shutting down our operations."(Company 3)

The pandemic highlighted the importance of worker welfare, potentially causing disruptions as brands reevaluate labor practices and implement changes to ensure safe working conditions. With the COVID-19 pandemic outbreak, due to health and safety reasons, companies focus on how to keep the workplace and their employees safe to restore their operations by reviewing their health and safety policies. To prevent the spread of the virus, companies reorganized and adapted their human resources for safety and hygiene purposes.

"Of course, the priority was human health. For instance, we closed shortly after Spain did – if I'm not mistaken, Spain announced its lockdown on March 23, and we followed it around March 28. Thus, the priority was everyone's health, followed by adhering to the directives of the brands. First, plans were made to protect the incomes of our employees and subsequently the incomes of employees at the subcontractors we work with." (Company 21)

Moreover, workspaces have been redesigned to accommodate social distancing and improved ventilation. Efforts have also been directed toward ensuring consumer safety by refining manufacturing, packaging, and delivery processes. Overall, the Covid-10 pandemic has witnessed businesses embedding health-focused safety capabilities into their supply chains as a long-term strategy, recognizing the necessity to be prepared for potential future disruptions that affect health issues.

Financial Capability

According to Pettit, Fiksel and Croxton (2010), financial strength is defined by a company's capacity to absorb fluctuations in cash flow. Similarly, in this thesis, financial capability is defined as effectively managing financial resources, investments, and risks through the supply chain to ensure profitability and sustainability in case of disruptive events that cause market fluctuations.

Financial buffering: Similarly, while the fashion supply chain is already full of uncertainty (Lo, Hong and Jeng, 2008), managing finances through contracts and payments was another crucial issue for fashion supply chains during the pandemic because of order cancellations, order postponements, delayed payments and other uncertainties. While such cancellations and postponements put great pressure on suppliers to maintain resilience in the supply chain, companies from the upper stream in the fashion supply chain network mentioned how this forced them to consider flexible payment strategies such as payment postponements. Further discussion with a respondent from a garment manufacturer demonstrates this as *"reacting as a buffer to*

protect suppliers", as the following quote testifies to this:

"We cannot do to our lower-tier suppliers what our customers do to us. There are different dynamics at play higher up, but further down the supply chain, there are workers waiting for their wages, employers who need to make payments. We couldn't receive our payments from customers, but we made those payments to our suppliers during these tough times. We acted as a buffer." (Company 3)

Postponement of payments: Furthermore, the same interviewee highlights the use of postponing the payments as a response to disruptions. They acknowledge extending payment terms as a practical strategy aligned with the adaptability needed in the supply chain. Yet, a key point is emphasized, that is, the company doesn't resort to this capability as much as its customers do. This clear statement underscores the company's commitment to a careful and tailored financial approach, highlighting its smart financial decisions in the face of today's business challenges.

"We were perhaps compelled to prolong the payment durations somewhat, but I can definitively say that we didn't extend them as much as our customers did." (Company 3)

Additionally, not only because of COVID-19 but also the volatility in Turkish Lira, and the ongoing currency crisis forced companies to make flexible adjustments.

"Financially everyone used to be focused on turnover. Cash flow wasn't given much thought, payment terms were stable, and we all had a fixed income. But the pandemic showed us that cash flow is the most important element, and flexibility in this area is one of the key factors." (Company 7)

Contract term arrangement: The ability to arrange contract terms, payment or credits can secure the whole supply chain's financial strength which has a crucial role in supply chain performance (Manders, Caniels, and Paul, 2017). For instance, the following quote illustrates a trade firm's ability in financial arrangements to become more resilient.

"For existing orders, we negotiated with manufacturers for discounts and price reductions. By securing price reductions, we were able to prevent some of our customers from canceling their orders. We found such a solution." (Company 14)

Financial support: In addition, the following interviewee from a focal company demonstrates financial support for a supplier and its benefits over the supplier side.

"We already know that some of our customers are global brands that lead the

sector in this aspect. They promptly made payments for the raw materials they had previously ordered, and we, in turn, ensured their continuity by making timely payments to them. In our processes, we made these payments to keep them both operational and more hopeful and motivated." (Company 8)

Moreover, based on the news content analysis in this thesis, McKinsey's research revealed that, amid rising costs and lower consumer confidence due to inflation, apparel companies are advised to employ the ADAPT model to protect margins. The model consists of Adjusting discounts and promotions, Developing strategic pricing, Accelerating decision-making processes, Planning for cost management through design modifications and product offerings, and Tracking consumer behaviors and market dynamics consistently. This approach allows businesses to navigate through inflation by being strategic with pricing and promotions, making informed and swift decisions, and continuously monitoring the market, thereby safeguarding their margins while staying competitive.

Flexibility

In the literature, flexibility has been defined in various ways. According to Manders, Caniels, and Paul, (2016, p.183), it is

"the ability of all members within the supply chain to adopt a chain perspective and change or react to environmental uncertainty and meet the increasing variety of customer expectations without excessive costs, time, and organizational disruptions or performance losses".

In this thesis, based on Manders et al. (2014)'s supply chain dimensions, and Pettit, Fiksel and Croxton (2010)'s flexibility capability factor, we have identified 5 flexibility types including *product development flexibility, sourcing flexibility, manufacturing flexibility, logistics flexibility,* and *capacity flexibility*. The interviews revealed that, among the selected companies, organizations at different tiers in the fashion supply chain prioritize different flexibilities.

Product Development Flexibility: Product development flexibility is a firm's ability to respond to changing customer needs and trends by introducing new products and modifying existing ones (Zhang, Vonderembse, and Lim, 2002). With the relaxation of lockdown restrictions, while the shift back to in-store purchasing hasn't fully turned back to the pre-Covid era, more consumers have begun shopping online

in greater numbers and frequency. he acceleration of consumers moving to online shopping from in-store purchases, the impact of the uncertainties and disruption caused by the pandemic is eased by utilizing the capacity to facilitate increased online sales. Most of the interviewees also highlighted that the change towards comfort dressing and loungewear eventually forced them to add new collection lines to their existing collections. For instance, one of the interviewees mentioned the impact of this growing demand on homewear collections and their *product development flexibility* as follows;

"We had to evolve towards more casual, home wear styles like joggers and three-thread fabrics from the more glittery, formal clothing. This increased the need for cotton and three-thread fabric production. More basic, comfortable clothes were made as people couldn't go out. This led to a decrease in the market share of more value-added, specialized fabrics like ours, which mainly produces women's outerwear. But what did it increase? Activewear and homewear. We made smarter investments in activewear during this period, allowing us to work with global giants in activewear. " (Company 22)

Sourcing Flexibility: Sanchez and Perez Perez (2005, p.686) defined sourcing flexibility as

"the company's ability to find another supplier for each specific component or raw material"

where in this thesis, it is also referred to as the ability of a firm to find alternative sources of supply in response to supply chain disruptions.

- Multi-Sourcing: In order to mitigate and prevent the spread of COVID-19, some of the companies reconfigured their logistical operations. E-commerce companies that became more popular during the lockdowns forced companies to adapt themselves to such speeds while delivering services to their customers. Because some of the delivery companies set capacity limits and gave quotas to their customers forcing the companies to utilize a wider supply base with alternative suppliers. Consequently, firms started to adapt their short-term strategies to build such logistics capabilities. For instance, a global clothing retailer company mentioned multi-sourcing in their logistics service supply by increasing the number of logistics service providers to minimize the risk of quote expiration. Because of the expectation of increased speed in delivery options each day, the logistics service providers eventually fall behind such

demands. The following quote exemplifies one of the selected company's *sourcing flexibility*.

"We increased the number of shipping companies we work with to spread the risk. We created a module here. We are now working with 13 companies simultaneously. We prioritized shipping companies for specific districts, 'First this company goes. If we can't get a label from them, or if there's an issue, then this one goes.' These companies started putting quotas on us like, 'If their quota is full, give it to this company.' We created a serious module." (Company 4)

Moreover, in line with previous findings, companies frequently mentioned the importance of being less dependent on sourcing to be more flexible and agile (Gyarmathy, Peszynski, and Young, 2020). For instance, some of the interviewees mentioned their firms' advantage of flexible fulfillment such as having multiple production facilities and multiple distribution centers in various locations which prevents vulnerability of single-site dependencies.

"The company adapts to changes and conditions because it doesn't manufacture in just one location but in many different places around the world, including numerous locations in Türkiye. Therefore, as long as there isn't a global problem, the company can somehow cope with it. Ultimately, it shifts production from one country to another, depending on the issue in that country." (Company 20)

- *Supply Base Diversification:* Findings also revealed that most of the interviewees agreed with the notion that, to mitigate supplier-side shocks, diversifying the supply sources may help better allocation of inventory levels (Talapatra and Uddin, 2019). While the need for localization and nearshoring of suppliers and resources were mentioned very frequently, some of the companies adopt flexible sourcing strategies to keep the supply chain resilient.

"We started looking for alternative countries. For instance, a disruption in China, where the virus originated, affects all our processes. As a supply chain, we said, 'We shouldn't rely on one country or location in these processes and need to change our structure. We should add supply paths from different countries.' After that period, we worked on this and began adding other countries to our portfolio. We aimed to source from different countries in case of any issues."

In addition to the interviews, the news content analysis findings also supported this. With the pandemic, restrictions and lockdowns forced fashion companies like H&M to build flexibility in their sourcing strategies by quickly diversifying their

sourcing locations (Financial Times, WWD, Just Style). Furthermore, due to geopolitical disruptions such as the recent Russia-Ukraine war, luxury fashion companies like Burberry, diversified its production locations, while initiating a proactive shift in its manufacturing, allowing them to prevent potential bottlenecks.

Manufacturing Flexibility: According to Siagian, Tarigan and Jie (2021), manufacturing flexibility is defined as a company's capability to modify its production levels. In the early stages of the pandemic, all the companies mentioned the demand crisis and forced shutdowns that occurred along the supply chain. As for their short-term plans, according to one of the yarn manufacturers in the fashion supply chain, with the demand shock, their partners canceled the orders which put the manufacturers in a very difficult position at first, eventually causing financial pressure to the company. Another company from a different tier in the supply chain demonstrated this by their approach towards semi-finished and finished products while canceling the orders. This fabric supplier illustrates their reactions as a result of brands canceling the orders as follows;

"Initially, the brands' first reaction was to maintain the status quo due to uncertainty about how much sales would be affected by the closures and quarantines. For example, let's say there's an order for 30,000 pieces. 10,000 were cut, the rest were in fabric form, 'Okay, stop there, don't sew.' Or, '10,000 were cut, but within this 10,000, 5,000 were in sewing, 5,000 were just cut in pieces, 'Okay, stop there.' If a certain amount was dyed, 'Then stop there.' Basically, the first reaction was to maintain the existing situation as it was on that day." (Company 11)

This tendency towards order cancellations and postponements continued for a while until companies turned back to their regular operations. To cope with the volatility in demand and uncertain lockdown and quarantine restrictions, they realized the need for production flexibility as the following interviewee from a fabric supplier demonstrates:

"The pandemic taught the sector a lot. We decided we needed to take precise steps in planning, especially in production planning. I mean, we produce our models, but we don't go into mass production with every model. We try to manage a customer perception. What products are directed by our customers, and what by us? Frankly, post-pandemic, we set a goal to expand our production line because we saw that the market hadn't really changed during the pandemic. The same amount of products would have been sold in a year as in that short period, but we couldn't meet the

demand in production during that short period." (Company 12)

Logistics Flexibility: Swafford, Ghosh, and Murthy, (2000) defined logistics flexibility as

"the ability to adapt, in a timely and cost effective manner, the process of controlling the flow and storage of materials, finished goods, services, and related information from origin to destination in response to changing environmental conditions. "

where in this thesis, it is defined as the ability to adapt and modify logistics operations and processes in response disruptions occured in the supply chain and it is analyzed in three dimensions that are *fleet flexibility*, *mode flexibility*, and *node flexibility*.

-*Fleet Flexibility:* Fleet flexibility is a firm's ability to offer various types of vehicles to transport different products (Naim, Aryee and Potter, 2010). Although freight operations continued somehow, to minimize the potential risks they have increased the company's own fleet as the following quote illustrates. This does not only prevent transportation-related risks but also provides faster delivery options for the company.

"A positive outcome of the pandemic for us was in reevaluating shipping risks. We increased our company vehicle fleet, making deliveries with our own vehicles to both our stores and customers." (Company 4)

- *Mode Flexibility:* Mode flexibility is defined as a firm's ability to offer various modes of transport (Naim, Aryee and Potter, 2010). Some informant companies preferred flexible modes of transportation options to mitigate network failures.

"We have reached a point where road transport to Europe, especially Germany, is almost as costly as air freight. This has led to a significant increase in road transport costs. We are now preferring air freight more. For example, we do all our small-scale exports by air now. Previously, it was mainly road transport. Now, the focus is on air transport." (Company 13)

Due to this notable increase in road freight costs, they have shifted their mode preference to using air freight for their exports, especially for smaller shipments. Companies need to be flexible in their transportation mode use, not only in times of

COVID-19 but also in other disruptive events such as the Suez Canal example. They need to be flexible in their mode of transport and adapt themselves to a disruptive environment.

"We're not relying on just one mode, like solely sea freight, but also considering rail for logistics. We're finding new ways. As I mentioned earlier, creating solutions with railways or air freight. Like sourcing by train when there's a delay. We try ways like bringing products by air freight when there's a delay, or we adopt a stock-based approach. After experiencing disruptions like the Suez Canal accident, it's clear that increasing rail transportation alongside sea freight would be beneficial for everyone."(Company 14)

-Node Flexibility: Naim, Aryee and Potter, (2010, p.41) defined node flexibility as

"the ability to plan, approve and implement new nodes in the network".

Similarly, in this thesis, it is defined as a firm's ability to add, modify, or remove nodes such as suppliers, distribution centers, etc. in case of supply chain disruptions. Regarding this, one of the global clothing retailer companies also mentioned this capability to cope with such disruptions by having distribution centers in several locations as follows.

"Unlike some companies that occasionally use a 'distribution center' or DC channel, we have a perspective that in major countries – and by major, I mean countries where we operate more than 10 stores – there's a need for a warehouse once you surpass ten stores. Of course, profitability and other factors are important in deciding to open a warehouse. As a result, we have about 15-16 warehouses overseas. These are not massive warehouses in terms of square footage, but they provide necessary relief. Because sometimes sales in the stores may not always go as planned, so you can send products back to the DC."

As the above quotes demonstrate, distributed inventory in multiple locations lowers such disruptions impact by providing flexibility of transporting the goods from the closest or in pandemic conditions, available location possible. The order will arrive more quickly in such options possibly lowering shipping costs while additional costs for warehousing may occur.

Capacity Flexibility: Managing capacity is revealed as a key resilience

capability in a supply chain, allowing businesses to bounce back more effectively after a disruption. According to Pettit, Fiksel and Croxton (2010, p.12), capacity as a capability is defined as

"the availability of assets to enable sustained production levels".

In this thesis, capacity is discussed in terms of a flexibility dimension and defined as a firm's ability to quickly adjust its production and/or service levels to meet changes in demand in case of supply chain disruptions. The interviews revealed that most of the companies developed capacity flexibility to cope with the demand fluctuations.

- *Safety Stock:* While the companies from different levels of the fashion supply chain mentioned keeping safety stock's importance in such disruptions, some of the companies mentioned how they keep stocks in supplier's or vendor's inventory. This also exemplifies that maintaining good relationships with vendors can be particularly beneficial in securing the required capacity in a timely manner. Although this may yield an additional amount of inventory on the supplier's or vendor's side, they have mentioned that informing them about their forecasts and forcing them to keep safety stocks eventually provided any kind of stockouts during that time.

"Capacity was abundant because everybody was canceling orders. So luckily this wasn't an issue at all. I mean, there was a first part where capacity was not an issue at all. And there was a second part where everybody was jumping on the vendors. And I would say that we had been a precursor there and we have been one of the first to go back into business mode. And that's why we were able to make sure that our vendor kept the capacity for us. And then it something it played it played a significant role in ensuring that we had enough capacity"(Under Armour)

Due to the volatile nature of demand and supply, the pandemic outbreak showed that redundant inventory (e.g., capacity buffers, high safety-stock) is another critical capability for the companies in the fashion supply chain. In line with previous findings, many interviews asserted that the increase in demand uncertainty forces firms in fashion supply chains to hold more inventory stock to buffer any supply chain disruptions (PWC, 2020).

"Our slightly higher stock levels during that period absorbed the issues that arose, allowing us as a company to pass through this period without significantly

impacting our customers." (Company 11)

- *Vendor managed inventory:* While many respondents highlighted the importance of inventory buffers, as mentioned in the above quote from a garment manufacturer, a different strategy of their own was implemented where they used their supplier's (fabric supplier) inventories. With the COVID-19 pandemic outbreak they've modified their inventory policies as also illustrated by a yarn manufacturer as follows,

"We've started adopting a strategy of keeping stocks at our suppliers. While this does add some pressure on them, we are moving towards an automotive industry approach, not very common in textiles. By providing forecasts, we enable them to prepare, and after preparation, ensure a quick supply... This is to prevent a situation where we are left without productsdue to any production issues at their end. We also coordinate with our suppliers regarding drawing products from their warehouses." (Company 11)

Such strategy eventually provides competitive advantage to the firm as excerpted also illustrated. This is also because of the growing importance of Türkiye's textile industry in the worldwide trade, because not only the change in consumer behavior increased the demand, but also with COVID-19 pandemic, textile orders moved to Türkiye due to the country's geographical advantage.

-Postponement: While managing on-hand inventory, some of the companies have stopped giving new orders. Similarly, another retailer mentions how they have postponed these orders as far as possible, as the following quote testifies this.

"At that time, there was no break in the supply chain or supply issues. But when we closed the physical stores, demand dropped to zero suddenly. No demand, but the supply continued. We tried to control the supply this time because the main source of revenue for retailers is still the physical stores, we are not a company that only relies on e-commerce. During that period, of course, when the retail side shut down, we tried to take the products later or slow down or postpone as much as possible." (Company 5)

-Pre-ordering: Before the pandemic, supply chain management trends heavily relied on just-in-time inventory management since it provides cost reduction while increasing efficiency. However, COVID-19 has revealed that this approach has failed to provide resilient supply chains for extreme conditions (Govindan, Mina and Alavi, 2020). The expert interviews revealed the importance of safety stock and creating

redundancy in the COVID-19 era. Not only retailer companies but also other players from different levels of the fashion supply chain also mentioned the importance of pre-ordering raw materials and creating redundant inventory to overcome volatilities for such demand shocks. Following quotes illustrate various perspectives of companies from four different levels in the fashion supply chain including cotton manufacturer, trade firm, garment manufacturer and retailer.

"The biggest strategic move we made was to purchase these textile products in advance. We made the deal knowing that the pandemic would end somehow, that this disease would end." (Company 4)

Nevertheless, the interviews revealed that securing capacity by having safety stock, redundant inventory etc. isn't just about ensuring continuity in companies' operations; it's also a financial strategy to protect themselves against market volatility. As following quote illustrates,

"By securing our inventory through advance procurement, we aimed to secure ourselves. Our raw materials might be delayed, might not arriv if ships are delayed.' We use both imported and local raw materials. We purchased in advance due to potential operational issues to avoid operational disruptions and because prices couldn't be trusted. Cotton that was 9 lira 1.5 years ago is now 60 lira. To manage prices effectively, we chose to source materials ahead of time (Company 23)

As illustrated by the above cotton supplier, raw material procurement and cost management are vital elements in the fashion industry. In this regard, the financial side of securing capacity in advance is crucial because it serves as a barrier against fluctuating prices, particularly in a country like Türkiye. In this regard, the company made advanced procurements due to potential operational issues and the unpredictable nature of prices. Thus, they strategically sourced in advance to better manage and stabilize prices. With the example of cotton prices skyrocketing, the upfront investment in procuring raw materials can lead to considerable cost savings in the long run. In the fashion industry, raw materials like cotton are foundational, and their supply and price stability are crucial for predictable operations and profitability. Above quote highlights the challenges faced by businesses in Türkiye due to the economic recession, characterized by significant currency and price fluctuations. Such drastic changes in commodity prices, as illustrated by the cotton example above, can be catastrophic for businesses if not managed effectively. For the fashion sector, where margins can be tight, and trends are ever evolving, such strategies can be vital for

building resiliency. Therefore, securing raw materials in advance helps companies to maintain production timelines, which in turn ensures that products get to market on schedule. This is particularly important in the fashion industry where trends can be seasonal, and delays could mean missing out on peak sales opportunities. This dual benefit makes it a significant capability for disruptions, allowing the firm to maintain both operational and financial stability.

-*Shifting fashion seasonality:* Additionally, while some of the companies focused on ensuring enough capacity, having more inventory on hand may cause several issues for fashion goods since they may cycle quickly due to the seasonality. The interviews revealed that, seasonality of the clothes and everchanging trends challenged fashion retailers to adapt their redundant inventory in such an uncertain environment. For instance, only one of the global clothing retailers mentioned that while it was spring when the first lockdowns occurred, they managed their inventory and prepared their collections to open in summer. They have allocated redundant capacity by shifting their collections to further seasons since they are not the trendsetters. So, they adapted their inventory management strategies to this new uncertain Covid-related lockdowns. For instance, another company, one of the suppliers of Türkiye's leading fashion retail brand demonstrates this capacity flexibility from his side as follows,

"Let me give you an example; products that should have been in stores six months ago, I'm just now selling their fabric. Because the initial 15-day delays turned into a month, then two. Consequently, the process that normally takes one or two months for collections to transform into pants, jackets, or other items extended to six months. This caused the collections to be delayed to the next year… Then, our customers placed the same goods in their stores as the 'new collection'. They continued with last year's products. They had us produce similar products again, let me say, from the same patterns and same fabrics. New collections are coming too, I don't know if you've noticed. Go to the new stores, the latest collections are just starting to arrive. So, our customers are generally running six months behind, I mean in terms of collections."

-*Labor Capacity:* Moreover, with the increased demand some of the companies started to increase their production volume while expanding their capacity. This forced them to increase their capacity, by having more *labor* in the workplace. The following quotes from two different focal companies testify to this,

"Our decision was to double our internal staff during the pandemic, maintaining a continuous hiring trend... While there were about 200, or rather 180 people working internally, now we have 400 employees. We did the opposite of what everyone else was doing. This turned out to be advantageous, as we are now one of the preferred suppliers among our customers." (Company 7)

"Our sales increased, our turnover increased, our capacity increased, and our number of employees increased." (Company 22)

Supply Chain Reconfiguration

Another highly discussed strategy is reconfiguring the supply chain. Building resilient supply chains involves reconfiguring them to be more adaptable, diversified, and efficient. Dolgui, Ivanov and Rozhkov (2020) describe Reconfigurable Supply Chains (RSCs) as networks designed to be cost-efficient, responsive, resilient, and data-driven. They are dynamically adaptable and capable of rapid structural changes in both physical and cyber spaces which allows for quick adjustment of supply and production capacities in response to market changes or disruptions.

Extending the supply chain: As illustrated in the below quote, by not relying excessively on a single source or region, a company can protect itself against localized disruptions. In essence, if a part of the supply chain is compromised in one region, operations can still be maintained through alternative sources in other regions. Reducing stock keeping units (SKUs) and enhancing fast minute responses align with the lean supply chain principles, where maintaining lower inventory levels and adapting quickly to market demands are critical. According to the respondent, this aspect is especially relevant given the nature of the Turkish fashion industry, characterized by a manufacturing outlook with limited long-term visibility.

"The most logical thing to do was to diversify the supply chain and have a broader base. 'If something happens here, there's an alternative there, this way the wheel keeps turning.' Everything we've talked about, from expanding the supply chain, reducing stock keeping units, to increasing fast minute responses, were part of this strategy." (Company 21)

Shortening the supply chain: While extending the supply chain, relying on local suppliers rather than cutting across multiple geographies may be safer to ensure supply chain resilience.

"I think the critical point here is to shorten the supply chain, which also reduces risk. Our company's main problem was that all products were distributed from

Türkiye. To overcome this, there was a significant shift towards direct sourcing. In the long term, plans were to increase this approach and actions involved acquiring new partners or developing existing ones. For instance, in the MENA region where the company has about 100 stores, we started planning to produce and distribute products directly from there. The company has established an operational entity in the MENA region with a significant team in place. This action of managing logistics and supply chain internally in that region is crucial. It's essential for large-scale, high-turnover retail chains to shorten their supply chain. This means moving production closer to the sales regions. Instead of importing raw materials from China, we'll do direct sourcing there, producing and distributing within the region." (Company 1)

As mentioned above, this company, one of the leader global retailer companies in Türkiye, recognized the potential of producing and distributing products within the MENA region itself, rather than centrally from Türkiye. This localization of production and distribution not only reduces the distance products need to travel but also allows for better adaptation to regional market demands. Establishing a dedicated MENA operation with its own logistics and supply chain infrastructure exemplifies a significant move towards a more efficient and responsive supply model. By sourcing materials and manufacturing products directly in these regions, the company aims to reduce the complexities and vulnerabilities of long-distance supply chains.

Similarly, another respondent mentioned the need for simplifying/shortening the supply chain to become more resilient, as following quote illustrates

"I would say it is the right time to also shorten the supply chain because today we have been thinking in a very fancy way. We needed to have the best yarn from country A, we needed to nick or spin in country B, we needed to cut in country C and then deliver to country D. And so there was a lot of logistic movements and so on and support. I would say that we should think as an older entrepreneur that wants to have everything under control under one roof. I'm not saying that this has to go under one roof, but I would say the same way we do with the processes we need to simplify the supply chain. End-to-end should be the third of the length that it is today. So if a lead time today can be, I don't know, 150 days, and we should target 50 days as a very, very optimistic approach. Because I think it's going to help everyone in the supply chain if you reduce the number of processes and the number of how much cash is stuck in the supply chain. A lot of supply chains are really expensive. (Company 2)"

Channel Reconfiguration: Another notable trend among the selected

companies revealed through the interviews is the strategic shift of sales channels from traditional physical stores to online platforms. This strategic shift towards digital channels is not only a response to evolving consumer preferences and digital trends but also a critical element in enhancing supply chain resilience. The following quote demonstrates a garment manufacturer's consideration of entering the online market marks a significant turning point, recognizing the importance of focusing more on and investing in online sales. This strategic shift can be seen as a capability to enhance supply chain resilience by adapting to digital channels.

"During this period, we thought about getting into online business more seriously. We realized the need to focus and invest more in online sales." (Company 12)

Collaboration

One of the highly mentioned concepts among the selected companies was supply chain collaboration to enhance resilience for several disruptive events that occurred in recent years. Supply chain collaboration refers to two or more supply chain actors working together to achieve a common goal (Simatupang and Sridharan, 2002). The recent COVID-19 outbreak again showed the importance of collaborations in highly competitive fashion supply chains (Wigley and Provelengiou, 2011). The pandemic outbreak has clearly shown that companies should build collaboration with their partners from different tiers along the supply chain (Paul et al., 2021). As the following quote demonstrates,

"After the initial shock, when customers also realized that 'we all are in this together,' they started to change their strategies and opened more doors for us." (Company 3)

New partnerships: While strengthening existing partnerships in the supply chain, it is also important to implement new strategic partnerships since such close relationships among supply chain networks could create significant value while building resilience. Following quotes emphasize this.

"Partnerships became important, we realized that. And because of this, we continued to form partnerships with different firms. We formed new partnerships and focused on increasing increasing them to ensure our security." (Company 25)

Joint- problem solving: In addition, joint-problem solving emerged as another notable collaboration aspect for building resilient fashion supply chains. The interviews revealed that fashion companies collaborate closely with their suppliers and

partners to solve various problems, ranging from material shortages to logistics adaptations.One of the companies also exemplified their collaborative relationship with their suppliers as a result of the global increase in paper prices. There exists several reasons behind this increase such as the instability in energy prices, particularly the increase in natural gas prices and the increase in timber and pulp prices which caused an escalation in paper prices. Such an unstable environment in prices and material shortages eventually caused paper mill closures in Europe. Moreover, the more people shop, the greater the demand on packaging materials. Therefore, the increase in packaging prices was another challenge to an already struggling supply chain. Following quote demonstrates a cotton manufacturer firm's collaborative approach to overcome such disruptions.

"For example, the prices of our packaging materials, spare parts used in production, or materials with petroleum or paper as raw materials increased rapidly. We developed a relationship with a paper based packaging material supplier, he says: "There will be an increase in paper prices in a week, I think you should buy it today, and I will by the raw material in advance. Let's do business like this, you win and I win too" (Company 23)

Similarly, another focal company exemplifies their joint-problem solving ability as a collaborative approach.

"Our clients also had something like this; They received their products without any delay. However, we have tried to solve all kinds of delays and problems of the client base we are currently working with internally." (Domino Tekstil)

Below quote also demonstrates the importance of a retailer's collaboration with its tier 1 and/or tier 2 suppliers.

"If there was no issue on the manufacturer's side, we canceled the order. If there was, we agreed to take it at a later date or postponed the payment. Yes, we have responsibilities like fabric costs, etc., but we negotiated with almost all manufacturers to deliver the product when we needed it." (Company 5)

Another retailer mentioned their collaboration with a logistics service provider to enhance their logistics capabilities while aiming higher customer satisfaction. They have made significant adaptations in their logistics approach by collaborating with a logistics company and established agreements with courier services to prioritize what customers value most: fast delivery. This swift delivery model was an impactful initiative, achieved by working closely with supply chain partners. The strategy they

have implemented involved delivering products directly from the manufacturer to the store, thereby eliminating the need for warehouses. They simplified their delivery system by removing individual cargo companies from the process, focusing on bulk shipments. Such adjustments also suggest a shift in logistics business models, where direct-to-store and bulk shipment methods can provide faster and more efficient delivery solutions. As illustrated in the following quote,

"During this time, we collaborated with a logistics service providers and made agreements with courier services. When you look at the entire process, what does the customer want? They want fast delivery indeed, so we focused on that. This was a significant project we carried out with our supply chain partners during this period. We implemented practices both in Türkiye and abroad, focusing on direct delivery from the manufacturer to the store, thus eliminating the need for a warehouses. Here, for instance, we removed individual courier services and implemented a model where we shipped boxes directly to multiple stores. The post-pandemic period really made us focus on these aspects." (Company 4)

Moreover, because of the increasing number of cases in workplaces, some of the companies worked closely together to monitor the spread of virus among the company. Such strategies can reduce potential negative impacts on manufacturers, ensuring continuity in supply chains and fostering trust. Following quote exemplifies Covid-related collaborative operations among the supply chain.

"We closely monitored suppliers during the pandemic, taking precautions accordingly. If they had stock and we refused to purchase it, they would be in trouble, so we suggested, 'Sell it to someone else, get your money,' or 'We'll take it and somehow sell it,' or 'We'll keep it in our warehouse for next year.' We were in constant communication, managing both financial aspects and production capacities. We even monitored everything, including the number of Covid-infected personnel, and all changes in capacity – we kept track of everything during that period.". (Company 5)

Co-value creation: With consumer expectations becoming increasingly demanding and changing each day, supply chain partners jointly creating products that resonate with customer demands becomes highly crucial. By working closely together, supply chain partners can not only meet but also anticipate consumer needs, leading to a more robust supply chain which eventually yields resilience.

"Now, the supply chain needs to move together. Previously, fabric manufacturers and we would market our collections separately. Now we need to work

together – I purchase the fabric from the manufacturer and turn it into a product. From now on, we need to work together. We have entered this working pattern. This cooperative approach has been well-received by some, but others prefer the old way. However, customer preferences are shifting towards a collaborative approach in the supply chain, demanding product presentations that focused on the goals set by the supply chain, and a concentration on specific product lines." (Company 7)

For instance, following quote demonstrates another dimension of co-value creation among supply chain partners;

"There were cost-cutting inititatives among partners. There have been a few projects especially related to size of the label and leaner processes on the label side. For instance, we usually receive all products in Türkiye and abroad at our warehouse before sending them to stores. We proposed, 'Why not have the manufacturers directly send the products to the stores instead?'. We initiated such a project, collaborating with manufacturers. We selected pilot manufacturers and adjusted their packaging accordingly. For example, if a box sent to the warehouse typically contained 40 products, we arranged for boxes sent to stores to contain 10 products each, distributed across four stores. We implemented such projects with manufacturers, focusing more on involving them in our processes." (Company 4)

Similarly, a focal company mentioned their business model change by increasing the supplier involvement in production processes which eventually reduces time lost in waiting for feedback and approvals, thus accelerating production. This collaborative approach is illustrated in the following quote.

"It also benefitted us because we regained lost time due to receiving these authorities. We saved time that was previously lost in waiting for approvals, responding to inquiries, and waiting for their return. Naturally, this reflected in the acceleration of our production. Lately, especially in the fashion and textile sectors, clients have completely changed their approaches. Previously, they used to stockpile products in warehouses before distributing to stores, but now they have minimized these product groups. They have increased the tendency to purchase using an 'open to buy' strategy, placing orders based on current sales. Previously, we operated with long-term planning, with average order lead times of 12 to 14 weeks. Now, it's reduced to 10 or 8 weeks. " (Company 7)

The shift in business dynamics as illustrated by the above quote highlights the evolving nature of fashion supply chain operations. In order to become more

responsive to market demands, fashion firms are handing over more decision-making autonomy to their suppliers. This approach not only accelerates production but also minimizes inventory costs and reduces waste, adapting to a more just-in-time model. Such shifts are vital in the fashion industry due to its inherent volatility and rapidly changing consumer demands and can greatly benefit companies in terms of cost savings, speed, and resiliency.

Moreover, companies often turn to innovative strategies to secure their market position, ensure long-term survival, value creation, and improve competitiveness (Jangga et al., 2015). This process of innovation is increasingly seen as an outcome of collaboration, involving various parties from within and beyond the supply chain (Arlbjørn, de Haas, and Munksgaard, 2011). Further quote demonstrates innovation as a result of collaborative approaches they have adapted in their supply chain.

"We have always been the preferred firm for fabric and yarn supply because of the attitude we have shown so far. This preference stems from our innovative and collaborative approach. For instance, when a fiber producer develops a new fiber, they want our company to test it first to promote it. Because we can creatively turn it into a unique fabric, and we don't charge for this. This collaborative approach keeps our relationships vibrant and cooperative. Let's say, when a company introduces a new sustainable fiber, I'll be the first to request a sample for trial. Initially, they would send it for a fee, but now they often provide it without charge for a joint promotion, saying, 'please make a collection with this. Let's showcase it together.' This establishes mutual trust, making both parties preferable choices." (Company 22)

Financial collaborations: As the below quote illustrates, supply chain collaboration is also crucial also from a financial perspective. Sharing financial responsibilities and risks, as mentioned above, can be beneficial for long-term partnerships. In volatile markets, collaboration in the supply chain can lead to more stable costs, enhanced resource utilization, and greater financial resilience for all parties involved. This shared approach can act as a financial safety net during times of economic uncertainty, making it a crucial aspect of business strategy in the fashion industry.

"After the initial shock, our customers began to realize more clearly that 'If these people don't exist, neither do we,' meaning that we're all in the same big ship together. Once they recognized this, they started to change their strategies and opened their doors a bit more to us. We covered their inventory costs. Even when we didn't

receive payments from our customers, we had to make payments to our subcontracted firms because people needed to receive their wages." (Company 3)

In addition to the interviews, the news content analysis finding revealed that H&M stood out by fostering strong partnerships with its suppliers, as seen through initiatives like the "Fair Wage Method." This collaborative approach ensured responsible labor practices and ethical sourcing, thereby contributing to a resilient supply chain that not only pay attention to ethical values but also benefits from close supplier relationships during times of uncertainty. Similarly, Zara, a prominent fast fashion brand, exemplified the power of trust-building through collaborative supplier partnerships. This not only enhanced operational reliability but also showed the importance of mutual trust between fashion companies and their suppliers.

Most of the companies mentioned that by using transparent payments companies provide trust and loyalty among supply chain partners. Considering the nature of the volatile environment with the recent pandemic, making payments on time and accurately yield trust among the supply chain.

"Flexibility and financial collaborations became very important, not in the sense of partnerships, but yes, the support of companies for each other, such as extending payment terms, was the most important thing in buidling trust during the pandemic." (Company 18)

For instance, the following quote of an interviewee from a global clothing retailer illustrates the company's trust building ability in financial terms. Developing trust by financially supporting a supply chain partner can be leveraged as a collaboration tool as following quotes demonstrate,

"Being in the supply chain, I can say that you need to protect your suppliers if you want your business to be sustainable. We maintained transparency and timely payments to our suppliers, which I believe increased their loyalty and tolerance towards us. We used our available funds wisely. Protecting your suppliers is essential for the sustainability of your business.." (Company 5)

Supply Chain Visibility

In today's fast-paced and globalized fashion industry, supply chain visibility has become one of the most critical capabilities for achieving competitive advantage in the fashion supply chain (Caridi, Perego and Tumino, 2013). Such capabilities are especially crucial given the unique challenges of the fashion supply chain, such as seasonality, fast-changing consumer preferences, and the urgent need for

sustainability. According to Caridi, Perego and Tumino (2013), supply chain visibility is the ability to share and/or acquire information across the supply chain. In a more precise definition, Kaipia and Hartiala (2006) defines it as "*The sharing of all relevant and meaningful information between SC partners, also over echelons in the chain*".

With the recent COVID-19 pandemic outbreak, building end-to-end visibility across supply chain tiers and echelons to prevent supply chain network failures becomes one of the top priorities among the companies. Multiple national lockdowns, different lockdown timing and cycles, increased border controls and customs regulations caused the major challenge for supply chains.

Within Company Information Exchange: Within company information exchange is a vital aspect of supply chain visibility, crucial for aligning various internal segments of an organization. It involves the efficient dissemination and sharing of critical information across different levels and departments within a fashion company. Effective internal communication is key to managing and adapting to the rapid shifts in market demands and supply chain disruptions, such as those observed during the COVID-19 pandemic. However, this sector faces unique challenges in communication, stemming from the fast-paced nature of fashion trends, the complexity of global supply chains, and the need for rapid decision-making. One of the interviewees from a global clothing retailer demonstrates the challenges of communicating the knowledge as follows,

"a lot of conflicting information was coming at the same time and also there is the inability to talk every day and because we are not in the office again. So the challenge has been really how to keep everyone united and how to keep the same front and how to make sure that we had the same approach. Because if one was basically acting a different way from the other you start having solutions and of course results that were not in the same direction and didn't give you the same outcome. "(Company 2)

Consequently, the continuity of operations across the supply chain is disrupted, providing real time monitoring and information sharing gained great importance to detect risks and prevent them. The interviews revealed that, in response to such disruptions, providing end-to-end information sharing along the supply chain in such multi-tier networks gained a great importance in terms of providing visibility (Ivanov, 2020).

"So what the reality was the most important thing was to have a weekly meeting

that was going through the company where we made sure that every problem was rising to the surface and every solution was deployed to the last employee so that everybody was aware of what was the priority for that 24 hours. And I would say that what is worth investing in is end-to-end solution that can help you know, creating visibility and transparency" (Company 2)

Supply Visibility: As described by Sheffi (2005) and Barratt and Oke (2007), supply visibility ensures that key stakeholders, including the focal firm and associated partners in the supply chain, possess timely and accurate information concerning the efficient supply of essential raw materials. The below quote further exemplifies the practical application of this concept during the pandemic, highlighting the importance of real-time information in such disruptions, potentially every two hours, to facilitate informed decision-making. This aligns with Sheffi's (2005) suggestion that, during disruptions, cooperative action among participating members relies on their ability to accumulate, assimilate, and draw meaningful conclusions from shared information. The following quote exemplifies supply visibility and its pivotal role in fortifying fashion supply chain resilience.

"During the pandemic, our primary focus was to provide real-time information. If necessary, every day, every two hours. Not after a week, because we don't know what a week, or even an hour, might cost in our suppliers' processes, maybe every hour counts." (Company 16)

Market visibility: With the COVID-19 pandemic causing disruptions on a global scale such as the global freight and container crisis and the intensified Turkish currency and debt crisis, companies are forced to maintain transparency with their business partners. The following quote demonstrates the importance of transparency in understanding market conditions, particularly in freight costs and fluctuating prices affected by currency variations. The constant changes in prices, especially during the pandemic, shows the dynamic nature of the fashion market and the need for real-time information to adapt strategies and operations effectively. Moreover, the pandemic has altered the traditional approach to pricing, shifting from pre-established rates to more flexible and adaptive arrangements, which shows the importance of market visibility on fashion supply chain resilience.

"We've been very transparent about freight charges since the situations are clear. We've also been transparent about the constantly changing prices. We've communicated this openly. The prices were constantly changing, especially in terms

of exchange rates. For instance, a yarn we discussed at 4-5 dollars initially would be 6 dollars by the time the order was placed. We experienced these issues and shared these changes transparently. It's not like before; we don't just follow a pre-agreed price. Because in the past, in export, the price discussed six months earlier would still be valid when the order arrived. But during the pandemic, this changed." (Company 13)

Market visibility, as defined by Williams et al. (2013) and Srinivasan and Swink (2018), is integral to enhancing resilience in the fashion supply chain. This concept highlights that the focal firm and its supply chain partners must possess comprehensive information about evolving market conditions, encompassing local regulations, political dynamics, and the evolving impact of technologies on customer preferences. Without such knowledge, firms would struggle to adapt their strategies and operations, hindering their ability to respond positively to disruptions.

While most of the companies mentioned their focus on building end-to-end visibility after COVID-19 pandemic outbreak, some of the interviewees also mentioned how the fashion industry still lacks supply chain visibility. As following excerpts also demonstrate,

"In our sector, end-to-end visibility is almost non-existent. We only consider the end product. We think only about our vendor, but the supply chain is not just that. It includes fabric manufacturers, yarn suppliers, zipper manufacturers, and the entire ecosystem. A strategy that encompasses this entire ecosystem needs to be developed. There's a lack of focus beyond the vendors. You need to be like an orchestra conductor because you are managing the supply chain, initiating the orders. There's a need for more orchestration." (Company 5)

Although it is still an issue in the fashion industry, and is highly criticized by the experts interviewed, recent pandemic outbreak forced companies to become more transparent and traceable. They have become more aware of the need for visibility in the supply chain.

"We tried to increase transparency and traceability. We realized that this needs to be done throughout the entire supply chain to achieve visibility." (Company 8)

Moreover, with increased examination over brands' and retailers' environmental impacts, there is a growing emphasis on the visibility of greenhouse gas emissions throughout the supply chain. This attention is spurred by the Security and Exchange Commission's proposed climate-disclosure rules and forthcoming EU

sustainable textile regulations. To assist brands in tracking and mitigating Scope 3 emissions (those within the value chain, making up to 98% of some retailers' total carbon footprints), the U.S. Cotton Trust Protocol was launched in 2020. This program enhances visibility over emissions produced at each stage, from farms to manufacturers, facilitating accurate reporting and targeted reduction efforts. The protocol has already recorded a 25% reduction in CO_2 emissions compared to 2015, with a goal of a 39% reduction by 2025.

Implementing visibility in the supply chain not only improves efficiency but also helps building resilience via monitoring potential risks (Ivanov and Dolgui, 2021). Since the fashion industry is highly known with its environmental and social impact, such capabilities provide control over the supply chain which eventually yields sustainability. Furthermore, according to the Global Sustainability Study 2021, increasing transparency helps building trust through showing their environmental and societal awareness. As the following quote illustrates, COVID-19 pandemic outbreak has accelerated the transition towards more sustainable fashion supply chains.

"There are still major issues with transparency, in my opinion. I'm not speaking for ourselves here, as the customer base we work with has been demanding this for years, and we comply. I'm in favor of transparency because it supports fair competition. Unfortunately, there are many unfair practices in the fashion industry. Transparency is crucial for this reason. Did the pandemic improve this? No, but now everyone, in line with sustainability goals, is discussing and bringing transparency more into the spotlight. The European Union, as you know, is drafting a law for the transparency of the entire supply chain. This is a positive development." (Company 19)

To increase traceability through the supply chain, some of the companies even made investments in digital technologies. For instance, a respondent from one of the garment manufacturers in the sample mentioned their ERP investments in their digitalization process which helps them to measure the efficiency. This provides a roadmap for the sustainable materials such as organic or recycled ones, which helps them, and their supply chain partners to track these materials from raw material to finished product any time in each stage.

According to Fashion Revolution's 2021 report, although supply chain transparency has increased, their progress remains slow. Since transparency provides social and economic concerns such as fair trade, gender equality, working conditions,

sustainability, fair wage, and child labor issues, without visibility of all the companies across the entire supply chain and traceability of all materials used, fashion brands may lose their accountability eventually. By implementing transparency and traceability, fashion companies can not only meet consumer demands for transparency but also build a more accountable, and resilient supply chain that can adapt to rapidly shifting market conditions. Moreover, the interviewees affirmed that transparency in information sharing, and digital transformation plays a key role in becoming resilient. Similar to Ivanov (2021)'s findings, to establish end-to-end visibility through the supply chain, digital technologies have been widely used such as blockchain technology, big data analytics and artificial intelligence, which are discussed in the next subsection.

Digital Transformation Capabilities

The interviews revealed that digital technologies have been widely used to maintain resilience during the pandemic. The essence of digital transformation lies in leveraging digital technologies to strengthen companies by deeply implementing and customizing digital skills. This enables companies to forecast potential risks, decrease the uncertainties they encounter, and enhance their capacity for risk management more accurately. In an industry characterized by its fast-paced nature and the necessity for swift decision-making, embracing these technological advancements is not merely an option but an essential strategy for building resilient and competitive supply chains. Moreover, with such technological advancements, the ability to present fashion shows and fairs online not only saves considerable costs but also significantly reduces the industry's carbon footprint, thereby contributing to companies' sustainability goals.

In line with the changes in trends and technologies, the recent COVID-19 pandemic outbreak brought the importance of digital to evidence. Companies were forced to utilize digital technologies more than ever. With the lockdown restrictions and the new working from home dynamics, all of the selected companies mentioned how COVID-19 boosted their digital infrastructure investments.

E-commerce capabilities: With the rise in online shopping, fashion companies have focused on advancing more in online channels to fulfill customer expectations and needs. With the increase in online sales, as expected, companies focus heavily on e-commerce. Even companies that did not have e-commerce sites before COVID-19 started using online platforms. Some of the retailers even mentioned that they have hired employees to utilize the e-commerce side.

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"With the insane growth in e-commerce volume, serious investments have actually been made in this area. The staff here was perhaps increased tenfold after the pandemic." (Company 1)

Since COVID-19 has led to a significant increase in online sales, this also forced companies to adapt themselves and their logistical partners to this new dynamic by utilizing e-commerce more. Companies having strategies such as the abovementioned one become resilient to such disruptive occurrences while having a competitive advantage however, as the following quote demonstrates companies having no logistical capabilities lag behind.

"Sales shifted to e-commerce, and couriers were able to continue their operations. Companies that adapted to this shift in sales towards e-commerce were not much affected, and some even increased their capacity as people, getting bored at home, began buying these products." (Company 8)

Additionally, companies started to focus more on online shopping to manage the existing inventory levels since in the beginning of the pandemic stores were mostly closed. Even with the relaxation of lockdowns, customers still hesitate on traditional in-store purchasing for a while.

"We started online sales. We have a lot of stock on hand because we couldn't sell off our inventory during that period. The trends are also something that change very quickly. You like something today, and three months later you start selling completely different things. We need to keep up with that. How can we utilize the stocks we have, the products that customers initially requested but then did not buy?"(Company 12)

Process Automation: Although e-commerce is a common investment option for the companies, particularly at the time when the stores were closed, the demand uncertainty in the fashion supply chain is still a big deal. Even once the global supply chains begin recovering from the effects of these extreme disruptions, today's fashion industry is very global and dynamic, customers are demanding shorter lead times and demand for these products is rarely stable or linear. As below quote demonstrates,

"if you think about it, demand is going to get more scattered than it was. The supply would be more disruptive that used to be. So at the end, the future is going to be harder and harder to match demand and supply. So I would say that instead of investing in manual calculation, we should invest in even having intelligence in the tool we use so that some of these calculations are basically done just by matching of a

demand and supply instead of trying to troubleshoot every day for innovative solutions at the end of there isn't really any innovative solution, because again we are just matching demand with supply. So I think that because it's going to be much more fragmented, I think we need the support of technology to help us."

Regarding forecasting and planning concerns, another respondent from a garment manufacturer highlighted the need for automation to mitigate risks while having accurate forecasts.

"I believe automation and planning are essential. If you can truly forecast a product, we thankfully have such systems in place now. You might have a product in hand, but if you don't know where to send it, you face significant risks. Our weakness is a bit in planning, in forecasting, because the PO is passed accordingly, and the product is sent to the designated location. Decisions can change in planning, but in the allocation part; if you have a product in hand, in the warehouse, this system sees the transit time of that country. If it goes to that country at that time, it knows the weather from past years and says, "This product will sell in that weather condition." It sees the sales, the stock, and every day there's a confirmation process telling you where to send what." (Company 21)

As mentioned by the above interviewee, by factoring in transit times and even weather predictions, companies can optimize the likelihood of a sale. This kind of precision becomes even more crucial in a global market, where misjudgments in distribution can lead to significant financial challenges. Similarly, another respondent from one of the global clothing retailers stated their focus on robotic process automation to eliminate recurrent operations to optimize their system.

"Especially after the pandemic, for the repetitive processes, we conduct sessions with operational units. In e-commerce, there are setups like batch receiving in warehouse management systems. There are batch logic, order picking logic, and different picking logics from different floors. We have many such systems. For example, if we're going to perform an algorithmic process or someone is pulling a report, then combining it with something else, and sending an email, you can automate all the tasks a person can do with the data in the system. Right now, our company is undergoing a transformation called 'robotic process automation.' We are in the process of transformation where we take these tasks and rather than having people do them, we have the system do them, enabling people to do more focused, value-added work." (Company 4)

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The same company also mentioned how they have benefited from the automated storage and retrieval systems (ASRS) during the COVID-19 outbreak. Because such automated warehouses provide a 10-fold improved performance where there already exists a shortage of personnel in the company due to lockdowns. Similarly, one of the garment manufacturers mentioned their investments on a smart building such as Amazon's Smart Warehouse.

Furthermore, while most of the companies mentioned their data security implementations during the time, others highlighted their focus on implementing more advanced ERP systems implementations.

Data Analytics and Artificial Intelligence (AI): Some of the companies also mentioned how their focus shifted towards big data analysis and data mining with the COVID-19, they even started to invest on data analytics tools as following quotes demonstrate,

"There was a lot of investment in data, and data was flowing from everywhere. However, the part about interpreting these data and turning it into action was perhaps not very advanced. We focused more on this, making deductions from these data during that period and forming actions and precautions related to them." (Company 16)

"Everyone tends to be able to access the information they want from wherever they want. You now want to instantly check the status of a production line anywhere. The customer also wants to see the status of their product instantly. The sector that gained value during this period is the information technology sector. When we look at the investment part now, we are talking about the investments of 2022, almost 80% of which are related to software. 'Let's get data, how can we evaluate it? What kind of software should we develop for this?' This is important for the sector. We are all trying to move in this direction." (Company 7)

According to above quotes, it's evident that both companies are aligned with Ngai, Chau and Chan (2011) concept of knowledge or information agility. This concept highlights the importance of not just collecting data but efficiently analyzing and leveraging it for competitive advantage. Both companies recognize the critical role of data analytics in enhancing supply chain resilience, particularly in the fashion industry where market trends and consumer demands rapidly evolve. This approach is essential for fashion companies to remain agile and responsive in such a dynamic market in order to convert data into clear, usable insights that supports strategic

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decisions and operational efficiency.

Additionally, while AI and machine learning technologies offer predictive analytics capabilities, allowing companies to foresee potential disruptions and consumer demand shifts, among the sample companies, only one company mentioned their AI utilization for forecasting and promotion purposes and their long-term plans concerning such technologies.

"We use an artificial intelligence algorithm, we have all our past data in it. Using this past data and recent changes in trends, it generates weekly, monthly forecasts for us, and it does this forecast based on product size, and physical stores. Now, we take these forecasts and decide 'What should I ship? What will I need for the future? Where will I lose sales? What am I missing so I can compensate for it next year?' and 'If I'm going to do a campaign, a discount, what should be the intensity, the extent of it?'. We usually talk about depth, breadth. 'How many products should I do it for and to what extent? 20%, 30%, 15%? Buy 2 get 3?'. To determine the intensity of these actions, we manipulate the predictions made by the algorithm. Here, we utilize interfaces that assess store availability, the accuracy of inventory levels, and the fullness of stock capacity in a similar manner. These types of systems are generally designed to interpret ongoing data streams, so they struggle to interpret a closed period, meaning the tool stops processing. Naturally, it can't predict 'what comes next.' What we are doing right now is modifying that algorithm, as everyone is focusing on KPIs. What we will encounter in the future is more important than what we are dealing with now. Therefore, we try to build our mechanisms, our algorithms on the model 'What awaits us in the future?' or 'Where will we fall short, where will we lose sales?'" (Company 5)

Such AI driven predictions can provide precise insights on rapidly changing fashion trends. However, such technologies still lack predicting the impact of future possible disruptions. Therefore, despite the advent of technologies and the rapid digitalization trend, there is still a need for state-of-the-art supply demand matching algorithms to cope with such disruptions.

Digital Visualization and Archiving: Moreover, since the fashion industry relies heavily on travel, due to mandatory travel bans during pandemic, they have been forced to advance more on the garment visualization capabilities to assess the quality of the garment. This is because to feel and touch the fabric plays an important role in the fashion industry. Although as challenging as it seems, several companies

mentioned their investments on equipment for displaying garments in the highest quality possible.

"With the impact of the pandemic, we improved our skills in product presentation in the digital environment, which we had already laid the foundation for, and set a goal to further increase them even more. We set a goal to increase them quickly. Maybe we would have done this after measuring for two years, such a big investment. But now we are trying to directly increase from three to five users to ten users and beyond in terms of design." (Company 8)

Following focal company further discussed their initiative on creating a comprehensive digital archive where it stores not just the finished products but also all the details related to the fabric used, such as its composition, color, and supplier.

"Firstly, becoming digitalized, we focused much more on digitalization in this aspect, feeling the need to display in the digital environment. We bought special programs for this. We also implemented certain projects related to the creation of digital fabric libraries." (Company 22)

In the fashion supply chain, a digital archive not only streamlines operations by making it easier to manage and reorder supplies, but it also allows for greater customization for customers, which in turn enhances customer satisfaction and engagement. This extensive database can also serve as a rich resource for predictive analytics and trend analysis, helping the company make data-driven strategic decisions. The digital nature of this system allows for quicker adaptability to market changes, which is crucial in the fast-paced fashion world. From a financial perspective, although setting up such a digital system requires an initial investment, it can lead to long-term cost reductions by removing inefficiencies and potentially increasing revenue through enhanced customer engagement and streamlined operations.

Additionally, news content analysis findings also revealed that Zara's strategic use of technology, including digital inventory management and automated order ulfilment, demonstrated the potential of digital transformation to optimize supply chain operations. By embracing digital tools, fashion companies can enhance responsiveness, streamline processes, and navigate disruptions more adeptly (BBC News, Just Style).

AR, VR and 3D Modeling: The digital transformation in the fashion industry provided recreation of the fabrics as digital garments that are designed by 3D models. One of the respondents from a yarn manufacturer again emphasized that the

challenging part for the industry during COVID-19 was the travel bans because they needed to show the fabrics physically. Since those fabrics are mostly designed on CAD systems, to adequately visualize the products companies focus more on 3D projects. For instance, the same respondent mentioned their investments in 3D mapping technologies to show their customers the highest quality visuals of their products while shortening the whole process by eliminating fabric sample production. As following quotes illustrates,

"Especially in 3D product design, there were some projects created to apply it both to suppliers and to raw material suppliers, in terms of fabric and pattern, instead of creating a physical product or sample, doing it in a digital environment. These had a huge benefit, a significant contribution." (Company 24)

In line with the recent trends, the interviews have supported that COVID-19 caused an acceleration in digital transformation in technologies such as virtual reality (VR) and augmented reality (AR) design, and virtual fitting rooms. Interviewees highlighted the importance of integrating such systems with the advent of Industry 4.0 technologies in terms of altering supply chain disruptions via sharing information transparently, accurately, and widely (Frederico et al., 2023). Following quote exemplifies this,

"We sew the fabrics we keep in our digital archive, dress them on digital mannequins, and provide a full digital package regarding the touch, softness, quality, and appearance of the desired product. This is also a new concept we call 'newers,' actually a project. This has now been implemented after Covid." (Company 3)

With the manufacturing technologies moving toward automation systems, via integration of Industry 4.0 technologies in smart factories and warehouses, and flexible manufacturing systems technologies the fashion supply chain can increase resilience by making the supply chain more agile and responsive.

Blockchain Technology: Interestingly, Blockchain technology did not emerge as a supply chain capability in the interviews, therefore it is discussed only based on the findings from the news content analysis.

In response to growing consumer demand for sustainable and traceable products, major fashion brands are turning to blockchain technology to increase transparency and fight counterfeiting in the apparel industry. The luxury apparel sector is grappling with challenges like the rapid increase in counterfeiting, leading to significant financial losses and brand reputation damage, and the rising importance of

environmental sustainability in consumer choices. Blockchain apparel solutions address these issues by providing digital provenance, which assigns a unique digital identity to each product. This approach allows the tracking of a product's life cycle from raw material sourcing to sale and resale, offering transparency and enhancing consumer trust. Brands like MCQ by Alexander McQueen have already implemented blockchain platforms to showcase their sustainability efforts and guarantee the authenticity of their products, thus fostering consumer confidence and promoting ethical consumption practices.

The fashion industry is increasingly exploring blockchain technology to address supply chain issues highlighted by the COVID-19 pandemic. Although blockchain is often misunderstood and overhyped, its understanding and application within the industry are growing, with many recognizing its potential to offer transparency, traceability, and efficiency to the supply chain process. Fashion brands are using blockchain to provide verifiable information on their sustainable and ethical practices, making data more accessible and trustworthy. The technology, which has its origins in decentralized finance (DeFi), is expected to evolve and play a significant role in the fashion industry's adoption of digital technologies like the Metaverse. Blockchain offers a reliable ledger of information, providing transparency into the supply chain from material sourcing to finished product, assuming the initial data entered is accurate. Brands are urged to adopt blockchain technology swiftly, as its implementation may take years, but its benefits for transparency and traceability in the supply chain are clear and substantial. Various companies and brands are already experimenting with and benefiting from blockchain, showcasing its practical applications and advantages in the fashion industry (Reuters).

According to a Forbes article, by 2030, the fashion resale, rental, repair, and renewal sectors could collectively be worth $700 billion. To leverage this potential while promoting sustainability and supply chain transparency, the fashion industry must focus on becoming data-centric and technology-driven, facilitating a circular economy. Digital traceability, crucial for a sustainable fashion industry, requires the integration of technology, including artificial intelligence and blockchain. These technologies can digitize supply chains, ensuring real-time data collection and sharing at each step of the production process, thus fostering transparency and trust.

Further discussion on digitalization revealed that the fashion supply chain still lags behind such digital technological advancements. Such technologies can help firms

to be more resilient to future supply chain disruptions and provide sustainability in supply chains (Ivanov Dolgui and Sokolov, 2019; Katsaliaki, Galetsi and Kumar, 2021).

Risk Orientation

Firstly, most of the companies mentioned having a lack of proactive strategies for such disruptions. Implementing strategies for becoming agile, flexible, and visible to become resilient was suggested by almost all the experts. However, for future disruptions more proactive strategies should be implemented to become resilient. Therefore, they've emphasized the importance of developing risk management. Some of the retailers further mentioned their focus on education during the production shutdowns, while raw material manufacturers highlighted their plans for sustainable cotton production and increasing synthetic fabric production. Among the twenty-five interviewed companies only two companies from different tiers of the fashion supply chain, a fabric supplier and a garment manufacturer, have created risk management culture way before the COVID-19 pandemic outbreak. They further discussed the importance of such strategies particularly in the fashion industry.

"In our company, we give significant attention to career management and risk management. We have risk committees, so, what are the risks? Risks from competitors, risks from companies that produce similar product groups, risks associated with the country's overall economic conditions, financial risks, ethical risks... As I said, sustainability in people, sustainability in management, etc., these are things we regularly discuss. This is because we truly operate a very different operation on a highly volatile ground." (Company 22)

"Actually, we employ a distinct approach compared to many other firms that operate in the same model as us. We have a 'risk committee.' In this committee, we employ several methods, but they are primarily based on the capital risk method, as determined suitable by our general managers and their teams, and then presented to the risk committee. As you know, we have a corporate group structure, and this committee, serving the corporate group, reports directly to the board of directors. Besides, each of our five textile companies brings their specific capital risks to this committee for classification. As we analyze risks in specific segments that directly impact the sector, including data from the Google risk report, we usually have many scenarios prepared. However, despite foreseeing these scenarios and having crisis management plans in place, we faced challenges, especially with timing, as it's

difficult to predict the exact moment when these scenarios would unfold." (Company 8)

These quotes above show that even companies with a risk perspective couldn't get the timing and adjustments right during such a disruption." A single risk committee may not be the adequate action for such disruptions. An additional pandemic committee may provide further insights to become prepared for such disruptions. Further discussion with a respondent from a global clothing retailer testifies this,

"While most companies started discussing in April, when the cases emerged around March or April, our company had actually put this on its agenda and noted it in the management's agenda in January. A pandemic committee was established, and we were planning. For example, a company from Italy was going to come in March, and our company said, 'It may be risky for you to come in March with the way things are going. We think that cases in Italy will emerge in March,' they had said."(Company 4)

On the other hand, findings revealed that, with the COVID-19 pandemic, companies that don't prioritize risk management culture before began to focus on having risk committees in their organizations.

Sustainability

Environmental concerns are becoming increasingly vital in shaping resilient fashion supply chains, particularly as sustainability becomes both a consumer demand and an industry requirement. These drivers are not merely ethical choices but strategic necessities for resilience in the fashion industry's supply chains. The increasing frequency of extreme weather conditions, accelerated by climate change, poses a significant risk to traditional supply chains. As a response, fashion companies are adopting more sustainable practices, including the use of eco-friendly materials and renewable energy in production processes, as a form of risk mitigation. These measures not only align with environmental regulations but also act as a buffer against disruptions caused by climate-related phenomena, such as hurricanes or floods, that could affect raw material sourcing or manufacturing capabilities.

Despite the growing global emphasis on sustainability, many fashion companies have been slow to adopt sustainable practices within their supply chains. Among the selected companies, only one respondent from one of the cotton suppliers mentioned their solar power investments after COVID-19, as the following quote illustrates,

"We implemented solar energy systems. We benefited from capabilities such as being able to see it remotely, receiving notifications on our phones when there is a problem. Because there isn't someone on the roof every minute, if the panels are not working, for instance, a message is sent." (Company 23)

Additionally, the changes in regulations related to trade, environment, and labor practices significantly impacts the fashion supply chain. Brands need to adjust themselves to comply with new regulations, potentially affecting sourcing decisions, production processes, and distribution strategies because non-compliance can lead to disruptions through legal penalties or reputational damage. The European Union's Green Deal, for instance, aimed to foster sustainable practices by imposing stringent environmental standards. This regulatory push translated to heightened demands for sustainable materials and processes. Brands like Adidas embraced recycled materials and eco-friendly manufacturing processes, reflecting an industry-wide pivot towards sustainability to align with regulatory expectations.

The findings revealed that regulations such as Global Organic Textile Standard (GOTS), Fair Trade and Green Deal is also another important driver that forces supply chains to become resilient. With such business certifications, companies commit to continuous improvement which eventually helps lowering the risks related to disruptions and lowers trade barriers (Giacomarra et al. 2016; Massoud et al. 2010).

"Regarding the certification, there are four or five balance sheets related to the traceability and transparency of the fabrics we sell. What we mean by balance sheet is this: how much cotton you have purchased, how many tons, and how many tons of it you have sold – this is systematically tracked by the licensed companies we work with. The purpose of the GOTS certification, for example, is this: It tracks how much organic cotton you have purchased and how much you have sold, and this is monitored online, invoice by invoice. Traceability in the supply chain of the products you provide is very important. Because in this GOTS certification, there is recycled fabric, cotton or recycled polyester, for example, these are currently in fashion, meaning customers now want to buy products according to the value given to nature by the fabric supplier or the value the customer gives to nature. And brands are allocating shelves in their own stores for these special products, saying, 'Look, made from recycled cotton. It's protecting the nature, see,'... Customers prefer linen, hemp yarns, and those not made with GMO cotton. Especially pregnant women, children... And actually, Gen-Z are aware of some of these. But of course, the prices for these are

very high at the moment. However, we have a specific segment of customers who are willing to pay for these, and we provide service to them."(Company 23)

The above quote also emphasizes a shift in consumer preferences, with individuals increasingly valuing products that reflect a commitment to environmental conservation. Therefore, while building resilient supply chains, they also meet consumer demands and which eventually provides a positive brand image.

"Customers are making certain things mandatory. Because they made it mandatory, you have to do it, even if you are not inclined to do them at all. I think that this should be a somewhat compelling factor to accelerate things. In this regard, we are one of the lucky producers on the H&M side, because H&M really believes in this and continuously supports it at every point as a retailer." (Company 7)

While such regulations force companies to adapt themselves to the industry standards, one of the global clothing retailers mentioned the monetary obstacles they face to meet such requirements. For instance, although their customers request them to pursuit Recycled Claim Standard (RCS 100) certification, some of their suppliers can't afford recycled fabric production because of inadequate investments in such implementations. The implementation of regulations covers multiple dimensions of the supply chain, including labor, environmental, and operational aspects. Regulatory changes have prompted strategic shifts in sourcing, manufacturing, and customer interactions. Brands adapted their practices to comply with new standards while also leveraging regulatory changes as opportunities to strengthen ethical and sustainable dimensions of their supply chains. Labor standards emerged as a focal point of regulatory changes, with increasing emphasis on ethical sourcing practices. For instance, some regulations were made to stop forced labor, like in the case of Xinjiang cotton. According to the findings of news content analysis, a New York Times article shows that fashion brands like H&M faced pressure to ensure transparency, leading to precise supply chain audits. Similarly, the same cotton supplier that invested on solar power systems that is mentioned above, demonstrates the increase in audits as follows,

"Audits have increased. Brands started conducting audits not only on their suppliers but also on their suppliers' suppliers. For example, an audit from Zara came to us. We installed some screens in our facility so that an employee's working hours and whether they are working under fair conditions can be observed. The employee has a card, and when they scan it, they can see how many hours they have worked that month, their overtime, the salary they deserve, and such things."(Company 23)

While only three companies among the selected sample discussed sustainability as a supply chain capability, sustainability concept in general is only mentioned as a future plan of the rest. Nevertheless, sustainability was the most mentioned theme among the secondary data gathered. For instance, according to Fibre2Fashion's article, the fashion industry, with a significant ecological impact, faces urgent calls for sustainability. It takes 3,781 litres of water to produce a pair of jeans, and the fashion sector accounts for 10% of global emissions—more than global flights and maritime transport combined. This could rise 60% by 2030 without timely intervention. Because since 2000, clothing production rates have doubled, leading to increased waste with 85% of textiles ending up in landfills annually. Moreover, washing these clothes releases microfibers into oceans, contributing to 31% of oceanic plastic pollution. Without change, the industry's carbon emissions could reach 26% globally by 2050 (Sustainabiltiy Mag).

In this regard, the fashion industry is undergoing significant changes towards a more sustainable future, with innovations in textiles and material sourcing. Designers and scientists collaborate to develop environmentally friendly materials. For example, Japanese designer Reiko Sudo uses kibiso, the traditionally discarded outer layer of a silkworm's cocoon, while other innovations include Nike's Flyknit sneaker made from recycled PET, and the training of plant roots to grow as pre-shaped materials. The Fashioned from Nature exhibition at the Victoria and Albert Museum in London showcases these innovations and raises awareness about the industry's environmental impact. It emphasizes the urgent need for sustainable practices, with the industry's carbon footprint matching that of the aviation and maritime sectors combined. Global warming's acceleration and depleting resources necessitate novel solutions, with many designers, like Stella McCartney, championing eco-friendly fabrics and sustainable practices (Vogue)

In addition, the regulatory landscape also influenced packaging practices within the fashion supply chain. Regulations targeting single-use plastics prompted brands to explore alternatives. Companies like Zara opted for sustainable packaging solutions, aligning with evolving regulatory expectations and consumer preferences for eco-friendly options. Furthermore, Nike had to adapt their product designs and manufacturing processes to comply with regulations like the European Union's REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) framework. Compliance efforts required adjustments to sourcing practices and the

adoption of sustainable materials which impacts the overall product development timeline. Beyond Nike, luxury brand Gucci had to navigate stricter regulations. Compliance with regulations on chemical usage required them to redesign certain products and work closely with suppliers to ensure compliance while maintaining their brand's high-quality standards. High-end fashion brand Prada had to comply with regulations restricting certain chemicals in clothing production. This required close collaboration with suppliers to ensure that their products met regulatory standards without compromising on their luxury design and quality. (Supply Chain Digital) (WWD)

Furthermore, the General Data Protection Regulation (GDPR) introduced heightened data privacy requirements, impacting the e-commerce facet of the fashion supply chain. Brands had to adapt to strict data protection standards to ensure compliance and maintain consumer trust. E-commerce retailers like ASOS altered their data collection practices and implemented robust security measures to navigate these regulatory shifts.

6.3. Barriers to Building Resilient Fashion Supply Chains

In today's highly complex and uncertain fashion dynamics, understanding barriers is crucial for fashion companies aiming to build resilient supply chains. The interviews revealed that companies may face potential barriers that obstruct them from achieving their goals while implementing strategies to build resilient supply chains. Therefore, it is important to understand and control such barriers to become resilient (Fawcett et al., 2008; Magnan & Fawcett, 2008; Roberta Pereira et al., 2014). The interviews revealed that there exists *economic*, *bureaucratic*, and *educational* barriers to building resilient fashion supply chains. Among these barriers, monetary reasons are the most obvious obstacle to resilience in fashion supply chains. Economic barriers that obstruct firms from implementing such strategies are the ones that economically challenge firms, such as the volatility in the Turkish Lira and the ongoing currency crisis in Türkiye.

Economic Barriers

The findings of the interviews revealed the economic barrier in the quest to build resilient fashion supply chains: *the high cost of sustainability*. Almost from all tiers along the fashion supply chain, companies highlighted the currency crisis and the pressure this puts on prices, which eventually forces companies to postpone their long-term strategies to cope with these challenges. As following quotes demonstrate,

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"These are huge costs. Thus, I believe this lack of resilient and sustainable supply chain implementation in Türkiye is also due to these financial burdens."" (Company 19)

"Companies should be allocating a budget for this. Even a company as large as ours, which wouldn't feel the pinch of such a budget, doesn't actually allocate one. This needs to be mandated by laws introduced by governments. Especially in our country, I definitely think this is the case." (Company 1)

"Companies don't have the money to spend on this. They are spending it on other things." (Company 22)

These companies acknowledge the critical importance of sustainable practices, yet they also point out the significant financial implications of such initiatives. This challenge is twofold, involving both the direct costs of implementing sustainable practices and the broader economic impact on a company's competitive positioning. On the one hand, sustainable practices often require substantial investment in areas such as eco-friendly materials, ethical labor standards, and greener production methods. These investments can be sizeable, especially for companies operating in highly price-sensitive markets. On the other hand, there's the issue of balancing these costs with the need to remain profitable and competitive. Many companies find themselves in a dilemma where prioritizing sustainability could mean compromising on profit margins or market share, especially in regions where there is less consumer demand or regulatory pressure for sustainable practices. This creates a challenging economic landscape where the long-term benefits of resilient supply chains must be weighed against the immediate financial realities and competitive dynamics of the fashion industry.

"Unfortunately, technology is very expensive in this country, and the current exchange rates are not helping. It's very expensive, but I think it will become mandatory soon with government support. The government is aware of this. Because we are using something that we get from outside." (Company 7)

Moreover, another issue that has an impact on monetary decisions of the companies is being dependent on external sources. With the growing importance of Türkiye's textile industry, the country having a lack of local resources is discussed as a crucial issue. Accordingly, with the volatility in currency, companies had hard time to cope with these everchanging prices, as below quote demonstrates technology prices which as mentioned before, is another requirement for companies to attain

sustainability and resilience in their operations.

"In the production of fabric and raw materials, we are increasingly relying on imported materials, but there are potential strategies to reduce this reliance and shift back to domestic materials. As I said, more sustainable products and materials can be developed. Recycling is very important here. In textiles, the biggest energy consumption goes into fabric production. We can move towards energy that is renewable and sustainable. Türkiye is very rich in this aspect. We need to move entirely in this direction." (Company 13)

In addition to the interviews, the news content analysis findings also supported the fact that, although the weakened Turkish Lira initially benefits textile exporters, the increased cost of importing raw materials and market pressures counteract these gains. From January to September 2021, while Türkiye's apparel exports grew by 25.72% to $13.364 billion, imports of cotton, cotton yarn, and cotton textiles also saw a significant increase of 34.2% year-on-year to $2.553 billion (Fibre2Fashion).

Bureaucratic Barriers

- *Import Dependency:* One of the fabric suppliers also highlighted that this external dependency on resources is their main vulnerability to extreme disruptions which obstructs them to implement such strategies. They further illustrate this barrier as follows,

"In the face of global crises or more dominant crises in our country, being in an import-dependent sector limits us significantly. As long as we don't overcome the issue of domestic production, we are always dependent on the outside, and we can't break this cycle. Will domestic production happen in these areas? Unfortunately, not. I'm speaking about our sector. Now, in cotton products, yes, alternative projects could be implemented, or different types of yarn could be developed for use in everyday clothing. These are alternatives, but in our sector, because these products are petroleum-based, it seems very difficult for us to overcome this sector without imports." (Company 12)

- *Energy Dependency:* Additionally, not only raw materials or fabrics, but also dependent on other country's energy resources seem to be another barrier as the following quote of an interviewee from garment manufacturer illustrates,

"We're a bit late, but... The world, Europe, and America started this earlier. We saw the disadvantages of relying too much on China or, say, Russia for energy during this pandemic. The demand for alternative energy production is forcing

everyone in our production line. We're too dependent on foreign energy, and this dependency is forcing everyone in our sector to work on alternative energy production methods." (Company 7)

- *Lack of governmental incentives:* Not only these external obstacles but also internal ones such as inadequate incentives for Research & Development projects, and managerial restrictions are also mentioned as barriers to resilience. For instance, an interviewee from one of the leading clothing retailer companies mentioned that, even though companies have the budget to implement these strategies, they do not want to spend it on such projects. Considering the growing importance in the economy of Türkiye in terms of GDP, exports, and employment, with such regulations by the government, eventually companies will be forced to create budgets for implementing resilience strategies. Following quotes by selected companies from different levels along the fashion supply chain exemplifies this.

"Textile industry is the top source of employment in our country. So, I think the necessary importance and incentives are not given. As a textile engineer, I'm saying this. The necessary importance and incentives are not given enough. Maybe they say dyeing plants harm the environment, consume a lot of water, and deplete water resources. Of course, thesehappen, but with incentives in certain regions, better and more regulated facilities can be established. I emphasize 'regulated' – it's essential to have regulation." (Company 13)

"In any case, large corporations and commercial enterprises will have to do these things, both due to legal requirements and customer demands." (Company 3)

"Looking at Türkiye, these things will have to be done with government incentives. If you set quotas, for example, if you give incentives for biomass instead of coal, then of course these will progress. But as I said, this issue, especially global warming, needs to be solved more at the government level, with a bit more awareness on their part." (Company 6)

"If the government incentivizes it, companies will turn towards it. And if companies incentivize it, employees will of course work in these areas." (Company 1)

These quotes collectively point to the necessity of aligning government policies, corporate actions, and employee engagement to overcome bureaucratic barriers, fostering a resilient and sustainable approach to fashion supply chain research and development.

- *Lack of sustainability measures:* In addition to the lack of governmental

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incentives, the absence of a unified approach or regulatory framework at the national level creates uncertainty and hinders the ability of manufacturers to align with sustainable measures. The lack of a clear calculation method or an emissions trading system, makes it challenging for businesses, particularly manufacturers, to take concrete steps toward sustainability. This lack of foundational infrastructure and regulatory clarity poses a bureaucratic challenge, making it difficult for fashion supply chain stakeholders to navigate and implement meaningful sustainability measures.

"Right now, Türkiye lacks a consensus on the electricity emission factor. There are discussions about joining green initiatives and the like, but there's no concrete calculation method in place. There's no emission trading system. What can producers do when the government doesn't have any system?" (Company 21)

The above quote also highlights the need for comprehensive and standardized policies to facilitate the adoption of sustainable practices within the fashion industry in Türkiye, from clear emission factors to a structured emissions trading system.

- *Instability of Regulatory Environment:* Similarly, an interviewee from a cotton supplier firm points out that bureaucratic barriers, particularly in the form of government interventions and the instability of regulatory frameworks, can significantly impede the fashion industry's efforts to develop resilient supply chains. A more stable, predictable, and less interventionist regulatory environment could provide the certainty needed for fashion companies to commit to long-term, sustainable supply chain practices. As following quote demonstrates,

"To build more resilient supply chains, perhaps the government or leading fashion retailers could try to ensure price stability. By price stability facilitated by the government, I mean the absence of interference. I believe that price stability is not achieved due to interference. When the free market economy is left entirely free, it will eventually find its balance in the long term. Things like this need to be more stable. There should be fewer frequent changes in legislation. Reducing intervention, in fact, would be the best intervention, I believe. (Company 23)

Moreover, the same interviewee also mentioned that although they have the budget to implement solar power systems, there still exists bureaucratic barriers such as newly added regulations and laws. Although in recent years Türkiye has made significant progress in terms of sustainability, more still needs to be done. This eventually provides awareness which yields us to the third obstacle that is mentioned by the companies that are, educational barriers.

Educational Barriers

- *Lack of know-how:* The interviews revealed that there's a significant lack of expertise and awareness among professionals in the field. The industry demands substantial know-how, with particular emphasis on skills such as carbon emission calculations. There appears to be a deficiency of individuals possessing this knowledge in Türkiye.

"But as brands become smaller in size, I mean as they become more localized, or move to corner shops, or even those slightly larger than them, they can't really do this job properly. It's a field that requires incredible know-how. For example, calculating carbon emissions – go and see how many people in Türkiye know how to do it. No one even knows where to get the training." (Company 21)

- *Lack of trainings:* Furthermore, the broader supply chain, encompassing suppliers, fabric and yarn manufacturers, and other stakeholders, reportedly lack a comprehensive understanding of the ongoing transformation and the challenges this presents. This lack of understanding inhibits the initiation of strategic discussions and planning essential for the development of resilient supply chains. In addition, there is a notable lack of investment in training and education aimed at fostering an understanding of resilient supply chains. Only a limited number of companies have articulated a clear vision regarding sustainability and resilience in their supply chains, providing necessary training to their employees in line with this vision. However, many firms reportedly lack such vision and are unwilling or unable to allocate funds towards sustainability initiatives, limiting the industry's overall capacity to adopt and promote sustainable practices.

"I consider my self lucky in this respect because our company has such a vision and provides us with training and support accordingly. We learn by living in this world how important and necessary it is, that this is our future... We are aware of this not just because the customer demands it, but because we are implementing it with a genuine consciousness. Unfortunately, many companies lack such a vision. They don't have the vision, nor do they have the funds to spend on it, spending it on other things instead. They don't see it as necessary because they can't account for themselves in the long term." (Company 22)

- *Lack of supply chain resilience orientation:* The quotes also suggest that many companies engage superficially with sustainability, incorporating it into their public relations strategy without integrating it into their core business strategies and

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visions. For meaningful change to occur, there needs to be a shift in mindset at both the corporate and individual levels.

"I think this is an ecosystem. We don't live alone. There's a supply chain from the supplier, fabric producer, yarn producer, to us. And I think they haven't fully understood yet what they are facing and what kind of transformation will happen. When they understand that, we can talk about total supply chain visibility, agility, but at the moment, companies, enterprises, and other members of the supply chain still seem to be fighting for survival. So, it will take some time for them to digest this. But after that, as I said, we can sit down and discuss a transformation, a strategy. Right now, we're only discussing strategy with our main partners, strategic business partners. Like, 'I'm going to do something in the next 8 months, 10 months, I'll have such a demand from you. What's your status? Are you ready? Make these preparations. I want this visibility. I want this flexibility from you.' We can only do this at a certain level. To make it more widespread, first, the supplier ecosystem needs to change. Secondly, they really need to come up for air, calm down, and think about what's happening. This is only applicable to businesses of a very limited and specific size." (Company 5)

- *Need for circular economy orientation:* Finally, consumer education is spotlighted as a crucial yet often overlooked component. For sustainable practices to be truly effective, consumers must be educated and engaged, supporting a shift towards more conscious consumption habits. This requires a concerted effort from brands and companies, many of which are currently failing to undertake consumer education initiatives, especially within the Turkish market. Without widespread consumer buy-in, the move towards resilient and sustainable fashion supply chains will likely remain limited and ineffective. The following quote demonstrates this urgent need for a paradigm shift towards circular economy thinking in the fashion supply chain to address sustainability concerns and promote resilience in the face of resource scarcity.

"In fact, we should be imposing this on consumers in a way. We need to be able to reach their minds. Currently, we are consuming the equivalent of 2.8 Earths. We are one Earth, but consuming like 2.8 Earths, consuming our future. Why are there United Nations Sustainable Development Agencies, the 2030 goals? Because resources are limited, but we don't act as if they are. People do this, after all. Especially in our labor-intensive sector, machines don't produce these; people sew them. They bring these products to life. Investment should be made in people, and

consumers' consumption habits should be changed. We should not be so wasteful with resources. This requires a change in perspective and thought process for everyone, every individual. For instance, the clothes you wear should be able to be worn second-hand by someone else. You need to believe in a circular economy. There's no need to have ten different colors of the same T-shirt you buy, or when a product lifecycle analysis is done, if it's 5 years, we should be able to give it a second chance and extend it to 8, 10, or 15 years." (Company 3)

CHAPTER 7: QUANTITATIVE STUDY

In this chapter, the characteristics of the problem being considered in the quantitative phase of the study will be discussed. Following the definition of the problem, the proposed mathematical models will be provided.

7.1. Formulation of the Clustering Problem

7.1.1. Problem Statement and Objectives

Building on the foundational insights gathered from semi-structured interviews with the twenty-five fashion companies, this phase of the study explores a quantitative analysis by employing a clustering model (1) to categorize companies based on their resilient supply chain capabilities, providing an empirical approach to understand the capability actions of companies in fashion supply chains regarding resilience. (2) to cluster the resilience capabilities utilized by informant companies, providing a refined and data-driven insight into how fashion companies combine various capabilities to enhance resilience in their supply chains. In this regard, the transition from the descriptive data of individual interviews to the numerical representation of capabilities across the industry spectrum serves as a cornerstone for the subsequent analytical part of the thesis. This analytical approach seeks to reveal the synergy between different capabilities, highlighting how their integration contributes to a more resilient supply chain in the fashion industry.

The quantitative part of the study is particularly significant given the limited research in the quantitative approaches of fashion supply chain resilience strategies, as highlighted by Abeysekara, Wang, and Kuruppuarachchi (2019). Integrating quantitative methods into our research design aims to bring a new level of analytical depth and precision to the study of supply chain resilience in the fashion industry, offering a fresh perspective and valuable insights into an area traditionally explored through qualitative lenses.

The objective is not only to fill this research gap but also to offer a nuanced understanding of the strategic combinations and interactions of various capabilities to build resilience in the ever-evolving and challenging domain of fashion supply chains. In this regard, this part of the thesis is twofold: firstly, *RQ4*, inquiries *"How can the selected companies be classified based on the supply chain capabilities they have built to become resilient?"*. This question steers our exploration towards a systematic classification of companies, unveiling fashion companies' diverse strategies and

capabilities to enhance their resilience. It clusters informant companies based on the supply chain capabilities they have developed to foster resilience. This classification provides a nuanced understanding of the resilience-based capability perspectives in the fashion supply chains and how different companies prioritize and develop these capabilities.

Secondly, *RQ5*, seeks to uncover: "*Which distinct resilience capabilities are strategically combined by fashion supply chain actors amidst disruptive events?"*. This aspect of the quantitative study focuses on the synergistic combination of capabilities within the supply chains. It aims to identify the specific capabilities that, when combined, contribute significantly to the resilience of the fashion supply chain. This analysis is crucial to understanding fashion supply chain capabilities and how their interplay and integration contribute to a robust and adaptable supply chain framework. By exploring these two dimensions, this thesis aims to unveil the complex interplay of capabilities within the fashion industry and how they collectively contribute to building resilient companies.

7.1.2. Mathematical Model

In this thesis, a mathematical model is introduced, which has been adapted from the formulation proposed by Rao (1971) for the purpose of optimizing the clustering of companies based on their supply chain capabilities. The original model by Rao (1971) was aimed at finding a partition within a dataset that minimizes the maximum distance within clusters through a mathematical formulation for cluster analysis. In this regard, the adaptation presented here extends Rao (1971)'s foundational model to specifically modifies to the unique requirements and characteristics associated with the supply chain capabilities of companies.

A data set is defined where N represents the set of companies, indexed by k, and M denotes the set of capabilities, indexed by i and j, where each company is characterized by multiple capabilities. The model aims to cluster the data set into distinct groups where each cluster is succinctly represented by its defining capabilities. Therefore, the objective is to minimize the maximum distance, denoted by Z, between companies and the centroid of their assigned cluster based on the relevant capabilities of those clusters. This is to make the least similar pair of objects (companies) as similar as possible, according to the distance measure.

The proposed model operates under a set of constraints to ensure that each company is assigned to one and only one cluster and that the relationship between

companies and clusters is accurately represented by binary decision variables x_{ik} and y_{ijk}. The decision variable x_{ik} indicates whether company i is assigned to cluster k, while y_{ijk} determines if company i and j are clustered together within cluster k. The distance d_{ij} represents the distance measure (squared Euclidean distances) of each company based on the comparison of code frequencies of each interview's transcription.

The model's constraints ensure the logical consistency of the clustering process, such as preventing a company from belonging to more than one cluster and ensuring that only feasible cluster assignments are considered. Therefore, each data point is exclusively allocated to a single cluster.

Sets and Indices

i, j Object number, $i, j \in M = \{1 \dots |M|\}$

k Cluster number, $k \in N = \{1 \dots |N|\}$

Parameters

d_{ij} distance between object i and j, $i \in M, j \in M$

Decision Variables

x_{ik} $\{1 \; if \; object \; i \; is \; assigned \; to \; cluster \; k, 0 \; otherwise$, $i \in M, j \in M$

y_{ijk} $\{1 \; if \; object \; i \; and \; j \; is \; assigned \; to \; the \; same \; cluster \; k, 0 \; otherwise$,

         $i \in M, \quad j \in M, \quad k \in N$

Z Maximum distance

$$\text{Minimize} \quad Z \tag{1}$$

subject to:

$$d_{ij}x_{ik} + d_{ij}x_{jk} - Z \le d_{ij} \qquad i=1,\dots,M\text{-}1; j=i+1,\dots,M; \forall k \in N \tag{2}$$

$$\sum_{k=1}^{N} x_{ik} = 1 \qquad \forall i \in M \tag{3}$$

$$y_{ijk} \le x_{ik} \qquad \forall i, j \in M, \forall k \in N \tag{4}$$

$$y_{ijk} \le x_{jk} \qquad \forall i, j \in M, \forall k \in N \tag{5}$$

$$y_{ijk} \ge x_{ik} + x_{jk} - 1 \qquad \forall i, j \in M, \forall k \in N \tag{6}$$

$$x_{ik} \in \{0,1\} \qquad \forall i \in M, \forall k \in N \tag{7}$$

$$y_{ijk} \in \{0,1\} \qquad \forall i, j \in M, \forall k \in N \tag{8}$$

$$Z \ge 0 \tag{9}$$

The objective function (1) minimizes the value of Z, which represents the maximum distance between any two objects in the same cluster. Constraint (2) ensures that for any two objects i and j, if either is assigned to cluster k, the distance between them (d_{ij}) does not exceed the maximum allowed distance Z for that cluster. This constraint helps maintain the compactness of the clusters by limiting how far apart any two objects in the same cluster can be, directly influencing the tightness of the clusters. Constraint (3) imposes that each object i is assigned to exactly one cluster by making sure that the sum of x_{ik} across all clusters k is equal to 1 for each object i. Constraints (4), (5) and (6) are used to linearize the model while ensuring that the binary variable y_{ijk} correctly indicates whether objects i and j are in the same cluster k. Constraints (7) and (8) define the binary nature of variables x_{ik} and y_{ijk}, respectively. Constraint (9) ensures the non-negativity of the variable Z.

7.2. Dataset Integration and Preliminary Analysis

7.2.1. Transition from Qualitative to Quantitative: Description of the Dataset

The dataset used in the mathematical model represents a structured quantitative synthesis of qualitative insights derived from an extensive analysis of semi-structured interviews with representatives from twenty-five fashion companies. Firstly, to capture and quantify the distances between the coded responses, MAXQDA software's Similarity Analysis tool is employed, which is illustrated in Table 14. This specialized analysis facilitated the construction of a distance matrix based on code frequencies, employing the Squared Euclidean Distance metric. This metric calculates the sum of squared deviations between the frequencies of codes, providing a nuanced measure that significantly weighs higher deviations, thus ensuring that our distance calculations are sensitive to the intensity of capability references across companies. The distance matrix, denoted by d_{ij}, is critical for the clustering model's objective function, which seeks to minimize the maximum distance within clusters, thereby ensuring that the grouped entities (companies or capabilities) are as similar as possible within each cluster while being distinct across clusters.

Table 24. Distance Matrix (MAXQDA)

Company	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0,00	15,02	33,51	15,02	1,77	15,02	44,66	30,47	30,27	103,89	56,62	24,22	15,71	26,82	23,06	9,47	48,99	3,20	1,43	49,66	21,05	19,18	5,73	46,48	59,97
2	15,02	0,00	45,67	27,17	16,79	0,00	56,81	48,36	48,16	118,91	68,77	36,37	27,86	41,84	38,08	24,49	66,88	15,35	13,59	61,81	33,20	31,33	26,49	61,50	74,99
3	33,51	45,67	0,00	45,67	35,28	45,67	69,26	60,82	60,61	131,37	87,26	48,83	34,28	54,30	38,45	42,98	85,37	33,85	32,08	68,23	45,66	43,79	44,98	73,95	87,44
4	15,02	27,17	45,67	0,00	16,79	27,17	56,81	48,36	48,16	91,74	68,77	36,37	27,86	41,84	38,08	24,49	66,88	15,35	13,59	61,81	33,20	31,33	26,49	61,50	74,99
5	1,77	16,79	35,28	16,79	0,00	16,79	46,42	32,24	32,04	105,66	58,38	15,39	13,94	21,53	24,82	11,24	50,76	1,43	3,20	47,89	19,28	20,94	7,50	44,71	61,73
6	15,02	0,00	45,67	27,17	16,79	0,00	56,81	48,36	48,16	118,91	68,77	36,37	27,86	41,84	38,08	24,49	66,88	15,35	13,59	61,81	33,20	31,33	26,49	61,50	74,99
7	44,66	56,81	69,26	56,81	46,42	56,81	0,00	74,98	74,77	145,53	98,41	62,99	51,46	68,46	39,72	54,13	31,74	44,99	43,22	66,75	59,82	57,95	56,12	88,11	101,60
8	30,47	48,36	60,82	48,36	32,24	48,36	74,98	0,00	38,19	107,58	55,59	54,54	35,91	44,95	44,47	39,94	76,60	36,54	34,77	62,76	46,07	44,20	30,47	49,98	69,72
9	30,27	48,16	60,61	48,16	32,04	48,16	74,77	38,19	0,00	107,93	49,98	54,34	42,81	54,07	44,27	39,74	63,89	36,34	34,57	76,76	23,78	49,30	30,27	73,73	40,90
10	103,89	118,91	131,37	91,74	105,66	118,91	145,53	107,58	107,93	0,00	145,07	103,54	106,46	127,69	117,89	113,36	152,88	107,09	105,32	133,30	107,04	120,05	109,62	147,35	138,85
11	56,62	68,77	87,26	68,77	58,38	68,77	98,41	55,59	49,98	145,07	0,00	77,97	50,67	83,44	79,67	47,15	95,97	56,95	55,18	89,20	51,70	62,33	68,08	80,82	14,55
12	24,22	36,37	48,83	36,37	15,39	36,37	62,99	54,54	54,34	103,54	77,97	0,00	20,43	26,84	38,22	33,69	76,08	13,96	22,79	54,38	28,79	37,51	35,69	57,08	81,17
13	15,71	27,86	34,28	27,86	13,94	27,86	51,46	35,91	42,81	106,46	50,67	20,43	0,00	29,43	20,65	25,18	67,57	12,51	14,28	32,69	24,32	25,98	27,18	46,77	50,85
14	26,82	41,84	54,30	41,84	21,53	41,84	68,46	44,95	54,07	127,69	83,44	26,84	29,43	0,00	40,82	36,29	48,64	22,96	28,26	63,38	37,79	42,98	32,56	44,56	83,77
15	23,06	38,08	38,45	38,08	24,82	38,08	39,72	44,47	44,27	117,89	79,67	38,22	20,65	40,82	0,00	32,53	53,11	26,26	24,49	54,60	35,05	33,18	28,79	60,47	73,96
16	9,47	24,49	42,98	24,49	11,24	24,49	54,13	39,94	39,74	113,36	47,15	33,69	25,18	36,29	32,53	0,00	58,46	12,67	10,90	59,13	30,52	28,65	15,20	55,95	50,50
17	48,99	66,88	85,37	66,88	50,76	66,88	31,74	76,60	63,89	152,88	95,97	76,08	67,57	48,64	53,11	58,46	0,00	55,06	53,29	92,19	60,41	71,04	48,99	95,47	96,46
18	3,20	15,35	33,85	15,35	1,43	15,35	44,99	36,54	36,34	107,09	56,95	13,96	12,51	22,96	26,26	12,67	55,06	0,00	1,77	46,46	17,85	19,51	14,67	46,14	63,17
19	1,43	13,59	32,08	13,59	3,20	13,59	43,22	34,77	34,57	105,32	55,18	22,79	14,28	28,26	24,49	10,90	53,29	1,77	0,00	48,22	19,61	17,74	12,90	47,91	61,40
20	49,66	61,81	68,23	61,81	47,89	61,81	66,75	62,76	76,76	133,30	89,20	54,38	32,69	63,38	54,60	59,13	92,19	46,46	48,22	0,00	58,27	59,93	61,13	65,01	89,38
21	21,05	33,20	45,66	33,20	19,28	33,20	59,82	46,07	23,78	107,04	51,70	28,79	24,32	37,79	35,05	30,52	60,41	17,85	19,61	58,27	0,00	29,04	32,52	55,68	40,02
22	19,18	31,33	43,79	31,33	20,94	31,33	57,95	44,20	49,30	120,05	62,33	37,51	25,98	42,98	33,18	28,65	71,04	19,51	17,74	59,93	29,04	0,00	30,65	30,16	65,53
23	5,73	26,49	44,98	26,49	7,50	26,49	56,12	30,47	30,27	109,62	68,08	35,69	27,18	32,56	28,79	15,20	48,99	14,67	12,90	61,13	32,52	30,65	0,00	52,21	65,70
24	46,48	61,50	73,95	61,50	44,71	61,50	88,11	49,98	73,73	147,35	80,82	57,08	46,77	44,56	60,47	55,95	95,47	46,14	47,91	65,01	55,68	30,16	52,21	0,00	81,15
25	59,97	74,99	87,44	74,99	61,73	74,99	101,60	69,72	40,90	138,85	14,55	81,17	50,85	83,77	73,96	50,50	96,46	63,17	61,40	89,38	40,02	65,53	65,70	81,15	0,00

Following a comprehensive analysis of the coding system, which was derived from semi-structured interviews, two distinct matrices were constructed: a matrix that interprets the relationships between selected fashion companies and the identified supply chain capabilities and a matrix that examines the interrelationships among the capabilities themselves. These matrices were precisely constructed to reflect the frequency of capability mentions within each company's strategic discourse. It should also be noted that these matrices were informed by a dictionary of relevant keywords (Appendix III), precisely constructed for each supply chain capability. Developing a keyword dictionary was a critical step in ensuring the accuracy and consistency of the coding process, enabling us to capture the full range of capability expressions within the dataset.

The matrix represented in Table 15 provides a detailed enumeration of the co-occurrence frequencies between twenty-five fashion companies and ten supply chain capabilities. This thorough coding process involved identifying direct and indirect references to each capability, as defined by the keyword dictionary, thereby capturing both explicit strategies and implicit operational characteristics discussed during the interviews. This not only enhances our understanding of individual company strategies but also provides insights into collective industry trends.

Table 25. Company-Capability Co-occurrence Matrix

	visibility	supply chain reconfiguration	digital transformation capabilities	collaboration	financial capability	agility	flexibility	health & safety management	risk orientation	sustainability
Company 1	0	0	4	0	0	1	0	0	0	0
Company 2	0	0	0	1	0	0	0	0	0	0
Company 3	0	0	0	0	0	0	10	0	0	0
Company 4	3	0	0	2	0	0	7	0	0	0
Company 5	4	0	0	0	0	5	0	0	0	0
Company 6	0	0	0	2	0	0	0	0	0	4
Company 7	0	10	9	1	0	0	3	8	0	0
Company 8	0	0	2	5	6	4	4	0	0	2
Company 9	4	0	8	4	0	4	9	0	14	0
Company 10	2	0	7	2	0	1	7	0	1	0
Company 11	0	0	0	0	0	0	0	0	0	0
Company 12	10	2	4	0	0	0	1	0	0	0
Company 13	2	0	0	1	0	0	1	0	0	7
Company 14	7	0	10	10	0	1	16	0	0	0
Company 15	0	0	0	0	0	5	4	0	0	0
Company 16	2	9	5	8	0	3	0	0	0	0
Company 17	6	0	10	7	0	7	14	12	0	0
Company 18	5	0	6	5	0	0	0	0	0	0
Company 19	0	0	0	0	0	0	0	0	0	0
Company 20	13	5	12	6	0	0	18	0	0	0
Company 21	6	0	9	0	7	0	12	0	10	0
Company 22	0	0	0	0	4	0	7	0	0	0
Company 23	3	0	5	2	0	8	0	0	0	0
Company 24	15	2	8	1	0	4	5	0	2	8
Company 25	0	0	6	5	0	3	6	0	0	2

Similarly, the matrix shown in Table 16 offers the frequency of co-occurrence between pairs of capabilities across all companies. It reveals how frequently pairs of capabilities, as outlined by the dictionary, are mentioned together in the discourse, providing insights into which capabilities are often interlinked in practice. This co-occurrence signifies potential synergies or dependencies between capabilities, indicating areas of strategic emphasis and potential collaboration within the industry's supply chain operations.

Given the model's objective to minimize the maximum distance, it was essential to convert the capability co-occurrence data to a normalized distance format. This normalization process, which is detailed in the subsequent subsection, is crucial for aligning the dataset with the model's requirements and ensuring the validity of the clustering results.

Table 26. Capability Co-occurrence Matrix

	Agility	Health & Safety Management	Financial Capability	Flexibility	Supply Chain Reconfiguration	Collaboration	Visibility	Digital Transformation Capabilities	Risk Orientation	Sustainability
Agility	0	2	6	8	0	0	0	2	0	0
Health & Safety Management	2	0	0	0	0	0	0	0	0	0
Financial Capability	6	0	0	0	0	18	0	0	0	0
Flexibility	8	0	0	0	48	0	0	0	0	0
Supply Chain Reconfiguration	0	0	0	48	0	0	0	0	0	0
Collaboration	0	0	18	0	0	0	24	0	0	5
Visibility	0	0	0	0	0	24	0	3	0	10
Digital Transformation Capabilities	2	0	0	0	0	0	3	0	0	0
Risk Orientation	0	0	0	0	0	0	0	0	0	0
Sustainability	0	0	0	0	0	5	10	0	0	0

7.2.2. Normalization of the Data

The raw data, which capture the frequencies within the semi-structured interviews of various companies, are transformed through normalization to ensure uniformity and comparability across the dataset. Given the variation in mentions among capabilities, the utilization of raw counts without adjustment could skew the resulting distances, thereby misrepresenting the actual relationships between capabilities. Therefore, a normalization method is applied to address potential biases. Each cell value in the co-occurrence matrix is divided by the grand total of all cell values. This transformation scales the raw frequencies into proportions relative to the entire dataset. Such normalization is pivotal as it facilitates the assessment of the relative prominence of each capability pairing within the collective dataset. It ensures that each pairing is evaluated based on its contribution to the total volume of discussions, thereby providing a uniform basis for subsequent comparative analyses.

This process adjusts values to a standardized 0-1 scale, with 0 indicating an absence of co-occurrence and 1 indicating the highest proportion of co-occurrence relative to total mentions. This scaling is not only a procedural necessity but also a foundational aspect of the clustering methodology applied within the study. The distance matrix, which is subsequently derived by subtracting the normalized values from 1, thus becomes the pivotal input for the clustering algorithm, enabling the accurate grouping of companies based on shared emphases on supply chain capabilities. Table 17 demonstrates the normalized capability co-occurrence matrix.

Table 27. Normalized Capability Co-occurrence Matrix

	Agility	Health & Safety Management	Financial Capability	Flexibility	Supply Chain Reconfiguration	Collaboration	Visibility	Digital Transformation Capabilities	Risk Orientation	Sustainability
Agility	0.00	0.99	0.98	0.97	1.00	1.00	1.00	0.99	1.00	1.00
Health & Safety Management	0.99	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Financial Capability	0.98	1.00	0.00	1.00	1.00	0.93	1.00	1.00	1.00	1.00
Flexibility	0.97	1.00	1.00	0.00	0.81	1.00	1.00	1.00	1.00	1.00
Supply Chain Reconfiguration	1.00	1.00	1.00	0.81	0.00	1.00	1.00	1.00	1.00	1.00
Collaboration	1.00	1.00	0.93	1.00	1.00	0.00	0.90	1.00	1.00	0.98
Visibility	1.00	1.00	1.00	1.00	1.00	0.90	0.00	0.99	1.00	0.96
Digital Transformation Capabilities	0.99	1.00	1.00	1.00	1.00	1.00	0.99	0.00	1.00	1.00
Risk Orientation	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Sustainability	1.00	1.00	1.00	1.00	1.00	0.98	0.96	1.00	1.00	0.00

7.2.3. Selection Criteria of Optimal Number of Clusters: Elbow Method

Within the quantitative scope of this study, the determination of the optimal number of clusters, or k, is recognized as a critical step, especially considering the significant influence the choice of k has on the outcomes of the clustering process. However, it's important to note that there isn't a universally applicable optimal number of clusters; the ideal count varies depending on the diversity in shape and size of the dataset in question.

While various methods can be employed to ascertain this number, the k-means algorithm has been chosen for its simplicity and ease of implementation in segmenting data. In this regard, the Elbow Method is employed as a heuristic to guide the selection of k. The Elbow Method is instrumental in analyzing the within-cluster sum of squares (WCSS), a metric that quantifies the compactness of clusters by measuring the squared distances from each data point to its cluster's centroid. In searching for the optimal number of clusters, the method involves plotting the WCSS against different k values and identifying the 'elbow' -the point where the decline in WCSS stabilizes and further increments in k yield diminishing returns. This method is particularly beneficial in k-means clustering, where the initial selection of k is a predetermined choice that significantly impacts the clustering results.

To implement the k-means algorithm and the Elbow Method, the code of the algorithms was built in Microsoft Visual Studio (Appendix V). Firstly, the model was run for the distance matrix, to determine the optimal number of company clusters. As illustrated in Figure 11, with an increase in the number of clusters, there's a corresponding drop in the WCSS value. The 'elbow' where the curve noticeably shifts direction, signifies the ideal cluster count. In this regard, the analysis of WCSS leads us to identify k=5, k=6, and k=7 as the optimal cluster values for this dataset.
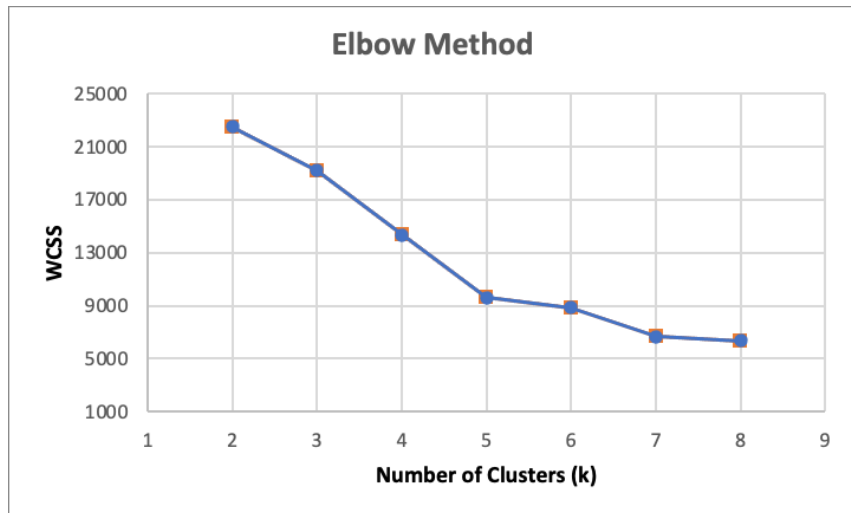
Figure 11. Elbow Method (distance)

Secondly, the normalized capability occurrence matrix was used to identify the optimal number of capability clusters. With the addition of more clusters, a reduction in the WCSS value is observed. Figure 12 illustrates that the optimal number of clusters corresponds to the points where there is a noticeable change in the direction of the curve, commonly identified as the elbow. Therefore, for this dataset, the clusters corresponding to k=3, k= 4 and k=5 have been identified as optimal.
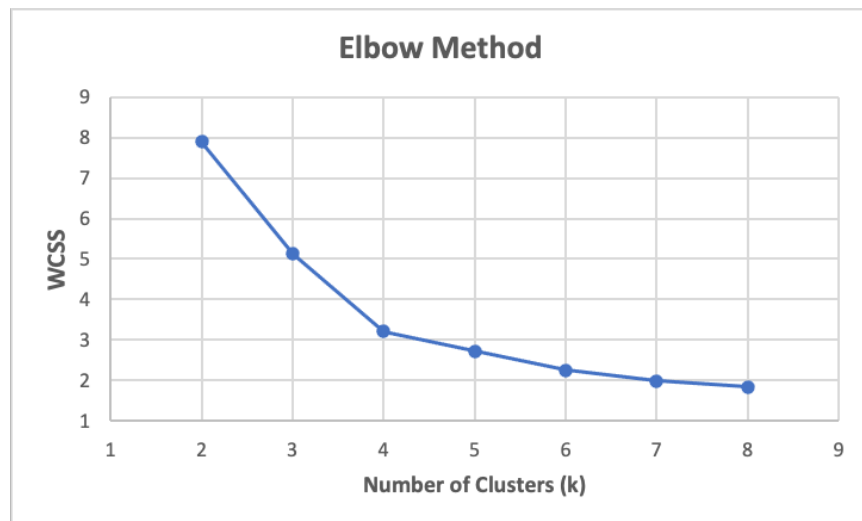
Figure 12. Elbow Method (company-capability co-occurrence)

7.3. Analysis and Interpretation of Cluster Results

Experiments were carried out on a 2019 MacBook Pro laptop with 2.3 GHz 8-Core Intel Core i9 processor and 16 GB RAM. The mathematical model was coded in IBM ILOG CPLEX Optimization Studio 22.1.1.0 (Appendix IV).

Initially, the focus was placed on the clustering of companies. Utilizing the distance matrix generated from MAXQDA's similarity analysis tool, a series of model runs were executed to ascertain the most informative clustering configuration. By employing the elbow method, the model was tested for different cluster configurations, specifically 5, 6, and 7 clusters, to distinguish the most meaningful grouping of companies based on their supply chain capabilities.

Subsequently, the analysis was directed towards the interrelationships among various supply chain capabilities. This step aimed to uncover patterns in the frequency with which certain codes appeared together. By analyzing these patterns, the study sought to understand if specific elements within the dataset were frequently mentioned in tandem, indicating a potential interdependence, or if they appeared more independently, suggesting distinct roles or functions within the broader context of the supply chain analysis. This inquiry involved running the model for 3, 4, and 5 clusters, aiming to shed light on the dynamics of capability utilization within the industry.

### 7.3.1. Analysis of Company Clustering Based on Supply Chain Capabilities

In each cluster size setting, the results highlight the complexity and multifaceted nature of the supply chain within the fashion industry. The strategic grouping of companies based on supply chain capabilities provides a framework for understanding the inherent relationships and potential synergies that exist among different entities in the industry. The diversity within clusters reflects the varied approaches companies adopt to enhance their resilience and maintain competitiveness in a dynamic market environment.

Cluster Setting 1. (k=5)

Firstly, the model was run with five clusters, resulting in a distinct categorization of companies (Table 18), which is shown in Cluster 1 presented a mix of companies, including those with an orientation towards raw materials and manufacturing. Cluster 2 predominantly consisted of companies characterized by their role as fabric suppliers. Cluster 3 brought together global clothing retailers, highlighting a concentration on the retail end of the supply chain. In Cluster 4, a variety of companies emerged, while Cluster 5 was exclusive to a global clothing retailer,

suggesting a retail focus within this cluster.

Table 28. Distribution of Companies Across Clusters for k=5

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Company 2	Company 1	Company 11	Company 4	Company 10
Company 3	Company 7	Company 21	Company 8	
Company 5	Company 17	Company 25	Company 12	
Company 6	Company 19		Company 13	
Company 9			Company 14	
Company 15			Company 16	
			Company 18	
			Company 20	
			Company 22	
			Company 23	
			Company 24	

Furthermore, as illustrated in Table 19, the supply chain capabilities that characterise each cluster were also revealed. Cluster 1, demonstrates an orientation towards flexibility, agility, and risk orientation, which are key for a dynamic response to the ever-changing fashion industry's demands and supply chain uncertainties. Their focus on risk orientation suggests a strategic approach to proactively address potential market disruptions, which is essential for sustaining operations in a competitive field. The absence of a focus on supply chain reconfiguration, financial capability, or health and safety management may indicate areas where the companies in this cluster could benefit from further development to enhance its overall supply chain resilience.

Cluster 2, though smaller in size, shows a significant engagement with digital transformation, flexibility, and uniquely, health and safety management, which is critical considering the likelihood of disruptions is increasing globally. The lack of emphasis on financial capability, risk orientation, and sustainability suggests these areas might not be the current strategic priorities or could represent opportunities for future growth. Moreover, their lack of focus on orientation may indicate a reactive rather than proactive approach to risk management.

Cluster 3, as a smaller cluster, has a focus on digital transformation, flexibility, and risk orientation, which are key capabilities for staying competitive and managing the fast-paced changes in the fashion industry. The notable focus on financial capability, even though it's less emphasized within the cluster, positions it well compared to others for financial robustness—a crucial factor for smaller entities

aiming for growth and stability. The absence of emphasis on health and safety management and supply chain reconfiguration indicates potential areas for strategic enhancement.

Cluster 4, being the largest cluster, exhibits a strong emphasis on visibility, which is critical in the fashion industry to maintain brand reputation and consumer trust. Coupled with a focus on digital transformation and flexibility, this cluster is likely leveraging scale to advance supply chain innovation and adaptability. The substantial focus on collaboration and a recognition of sustainability, although not the main emphasis, suggests an awareness of the importance of cooperative partnerships and eco-friendly practices in shaping a resilient, large-scale supply chain.

Cluster 5, the smallest cluster, focuses considerably on digital transformation and flexibility. In the fashion industry, this focus may represent a strategic decision to use technology and adaptability as key tools for maintaining resilience.

Through this analysis, it is evident that while there is a common recognition of the importance of digital transformation, flexibility and visibility across the clusters, except for Cluster 2, there is a general lack of focus on health & safety management, indicating that while it may be of importance to the industry, it is not currently a central part of most clusters' supply chain strategies. This could reflect an opportunity for industry-wide improvement, particularly as consumers and regulators increasingly value corporate responsibility and ethical practices.

Table 29. Aggregated Capability Metrics by Cluster for k=5

	visibility	supply chain reconfiguration	digital transformation capabilities	collaboration	financial capability	agility	flexibility	health & safety management	risk orientation	sustainability
Cluster 1	1.33	0	1.33	1.17	0	2.33	3.83	0	2.33	0.67
Cluster 2	1.5	2.5	5.75	2	0	2	4.25	5	0	0
Cluster 3	2	0	5	1.67	2.33	1	6	0	3.33	0.67
Cluster 4	5.45	1.64	4.73	3.64	0.91	1.82	5.36	0	0.18	1.55
Cluster 5	2	0	7	2	0	1	7	0	1	0

Cluster Setting 2. (k=6)

When the cluster size was increased to six, the model delineated companies into more nuanced groupings (Table 20). Cluster 1 was observed to be a convergence of fabric suppliers and global clothing retailers. Cluster 2 and Cluster 3 demonstrated a mix, with focal companies in production and other roles. Cluster 4 appeared to house companies with a strong presence in global retailing. Cluster 5 showed a mix of suppliers and manufacturers, and Cluster 6 was a blend of fabric suppliers and global clothing retailers, implying the overlapping roles in supply chain operations.

Table 30. Distribution of Companies Across Clusters for k=6

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Company 9	Company 8	Company 7	Company 1	Company 2	Company 10
Company 11	Company 13	Company 17	Company 20	Company 3	
Company 25	Company 14			Company 4	
	Company 18			Company 5	
	Company 19			Company 6	
	Company 22			Company 12	
	Company 24			Company 15	
				Company 16	
				Company 21	
				Company 23	

Additionally, Table 21 shows the supply chain capabilities that characterise each cluster for k=6. Cluster 1, consisting of three companies, is distinguished by a pronounced focus on digital transformation, flexibility, and risk orientation. This cluster stands out particularly for its approach to risk orientation, which is a critical component in navigating the complexities of fashion supply chains.

Cluster 2, with seven companies, emphasizes visibility, flexibility, and digital transformation, alongside collaboration. These capabilities are indicative of a cluster which includes companies that value a transparent and responsive supply chain, enhanced by strong cooperative relationships. While health and safety management does not appear to be a focal point, this cluster does focus more on sustainability than other clusters.

Cluster 3 is a smaller group of two companies, yet it distinctly prioritizes health and safety management—a capability not emphasized by other clusters. Alongside health and safety, this cluster also focuses on digital transformation and flexibility. Although other capabilities such as supply chain reconfiguration, collaboration, and

agility, are not as emphasized, they still stand out relative to the other clusters, suggesting a versatile approach to supply chain resilience. Risk orientation and sustainability are not areas of significant focus for this cluster.

Cluster 4, a group of two companies, has a strategic focus on flexibility, visibility, and digital transformation. The cluster particularly stands out in visibility within the fashion industry, which is key to monitoring the supply chain and ensuring product integrity. Additionally, it has the most pronounced focus on supply chain reconfiguration compared to other clusters, though this capability is not as emphasized as the others within its own cluster.

Cluster 5, which is the largest cluster with ten companies, presents a balanced approach to capabilities, with no single capability dominating its focus. This suggests a diverse but evenly distributed strategy, where all areas except health and safety management are addressed, albeit to a lesser degree.

Cluster 6, being the smallest with just one company, concentrates on digital transformation and flexibility. The absence of a focus on supply chain reconfiguration, financial capability, health & safety management, and sustainability indicates that this cluster's strategy may revolve around leveraging digital innovations and maintaining operational adaptability to navigate the fashion supply chain.

In summary, across the clusters, except for Cluster 3, there is an overall lack of emphasis on health and safety management, suggesting that while it may be critical within the industry, it is not a central part of most clusters' operational strategies. Flexibility, agility, visibility and digital transformation are acknowledged by all clusters, reflecting a sector-wide recognition of the importance of these capabilities in ensuring supply chain resilience amidst the fashion industry's rapidly evolving landscape.

Table 31. Aggregated Capability Metrics by Cluster for k=6

	visibility	supply chain reconfiguration	digital transformation capabilities	collaboration	financial capability	agility	flexibility	health & safety management	risk orientation	sustainability
Cluster 1	1.33	0	4.67	3.00	0	2.33	5	0	4.67	0.67
Cluster 2	4.14	0.29	3.71	3.14	1.43	1.29	4.71	0	0.29	2.43
Cluster 3	3	5	9.5	4	0	3.5	8.5	10	0	0
Cluster 4	6.5	2.5	8	3	0	0.5	9	0	0	0
Cluster 5	2.8	1.1	2.3	1.5	0.7	2.1	3.4	0	1	0.4
Cluster 6	2	0	7	2	0	1	7	0	1	0

Cluster Setting 3. (k=7)

With seven clusters, the analysis revealed even more subdivisions among the companies (Table 22). Cluster 1 was composed of a variety of roles, including global clothing retailers and fabric suppliers, suggesting a broad range of capabilities. Cluster 2 was marked by a strong presence of semi-processed material suppliers and trade firms, indicating a mid-stream supply chain focus. Cluster 3 included yarn manufacturers and global clothing retailers, reflecting a link between raw material provision and end-product retailing. Cluster 4 to Cluster 7 displayed a diverse mix of companies, ranging from raw material suppliers to global retailers and focal companies in production, illustrating the diverse strategies and operational capabilities within the fashion industry's supply chain.

Table 32. Distribution of Companies Across Clusters for k=7

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Company 1	Company 13	Company 18	Company 10	Company 7	Company 11	Company 4
Company 2	Company 14	Company 19		Company 17	Company 25	Company 8
Company 3	Company 22	Company 20				Company 9
Company 5	Company 24					Company 16
Company 6						Company 21
Company 12						Company 23
Company 15						

Additionally, as illustrated in Table 23, Cluster 1, encompassing seven companies, shows an orientation towards flexibility and visibility. These capabilities are essential in the fashion industry for adapting to market fluctuations and maintaining transparency, although no particular capability stands out as a dominant focus.

Cluster 2, with four companies, is characterized by a multifaceted approach, balancing visibility and flexibility with digital transformation, sustainability, and collaboration. This cluster notably places a substantial emphasis on sustainability, more so than others, and it is the only cluster where financial capability is recognized, albeit not as a central focus within the cluster itself.

Cluster 3, a smaller cluster of three companies, prioritizes visibility, digital

transformation, and flexibility in its supply chain strategy. The absence of a focus on supply chain reconfiguration and agility in this cluster is notable, indicating a selective approach to the capabilities they consider crucial for resilience.

Cluster 4, the smallest with just one company, demonstrates a focus on flexibility and digital transformation, indicating a reliance on adaptable and technology-driven supply chain strategies to navigate the fast-paced fashion sector.

Cluster 5, with its two companies, is particularly focused on health and safety management, a capability that is not only unique to this cluster but also the most emphasized one within the cluster itself, signalling a strong commitment to safe practices and well-being in the workplace. In tandem with this, the cluster has a substantial focus on digital transformation, more so than any other cluster, highlighting a strategic thrust towards leveraging technology for innovation and competitive advantage. Flexibility is also a key component of this cluster's strategy, suggesting agility in adapting to the dynamic demands of the fashion market. Furthermore, while supply chain reconfiguration is not the primary focus, it receives more attention in this cluster relative to others, indicating an awareness of the need to evolve and optimize supply chain processes for greater resilience.

Cluster 6, also a smaller cluster with two companies, exhibits a focus on flexibility, digital transformation, collaboration and agility, with a mention of sustainability. Cluster 7, including six companies, focuses on digital transformation capabilities, flexibility, and risk orientation, with the latter being a particularly strong focus relative to the other clusters. Financial capability, while not the main emphasis, is also given more attention in this cluster compared to others, suggesting a strategic approach that includes financial health as part of their resilience strategy.

Across all clusters, except for Cluster 5, there is generally no emphasis on health and safety management. Flexibility and digital transformation are common threads, highlighting their critical role in building resilient supply chains within the fashion industry. Each cluster's specific focus reflects a strategic approach to navigating the challenges of supply chain management, with some clusters emphasizing sustainability and risk management more than others, indicating a diverse array of approaches to resilience in the face of industry disruptions.

Table 33. Aggregated Capability Metrics by Cluster for k=7

	visibility	supply chain reconfiguration	digital transformation capabilities	collaboration	financial capability	agility	flexibility	health & safety management	risk orientation	sustainability
Cluster 1	2.00	0.29	1.14	0.43	0	1.57	2.14	0	0	0.57
Cluster 2	6.00	0.50	4.50	3.00	1.00	1.25	7.25	0	0.50	3.75
Cluster 3	6.00	1.67	6.00	3.67	0	0	6.00	0	0	0
Cluster 4	2.00	0	7.00	2.00	0	1.00	7.00	0	1.00	0
Cluster 5	3.00	5.00	9.50	4.00	0	3.50	8.50	10.00	0	0
Cluster 6	0	0	3.00	2.50	0	1.50	3.00	0	0	1
Cluster 7	3.00	1.50	4.83	3.50	2	3.17	5.33	0	4	0

Additionally, the overall clustering results shows that, Company 10 stands out as consistently placed into a cluster on its own for each examined k-value. This distinct separation suggests that Company 10 possesses a unique combination of supply chain capabilities that set it apart from the others. On the other hand, Companies 7 and 17 are clustered together across all examined k-values, which implies a strong similarity in their supply chain capabilities or strategies. This consistent pairing could be due to shared supply chain practices, market approaches, or collaboration between these companies. It might also reflect a common business model or customer base that aligns their operations closely.

Global clothing retailers appear in various clusters but often find themselves grouped together, particularly in higher k-values. This might suggest that while there are overarching similarities among retailers, there are also nuanced differences that become more apparent as the granularity of the clustering increases.

Another interesting observation is the grouping of companies with a focus on raw material supply and manufacturing (such as yarn manufacturers) with global clothing retailers in certain cluster configurations. This could indicate a strategic alignment in the supply chain, where upstream and downstream operations are closely linked.

The presence of fabric suppliers across different clusters suggests a diversity of strategies or capabilities within this category. They seem to represent a versatile group within the supply chain that aligns with various other company types, possibly due to the pivotal role fabric suppliers play in the fashion industry.

7.3.2. Analysis of Interrelations Between Supply Chain Capabilities

The interrelations between supply chain capabilities have been methodically examined through the application of a clustering model, with an increasing number of clusters providing a more segmented view of capability intensity. The analysis is based on the capability distributions across clusters for different cluster counts (k=3, k=4, and k=5), as summarized in the respective tables.

As illustrated in Table 24, the three-cluster model offers a broad overview of capability alignment. Cluster 1 is characterized by operational capabilities such as agility, health and safety management, and flexibility. This indicates a focus on responding rapidly to short-term market changes while also maintaining the structural adaptability to navigate long-term shifts in the fashion supply chain. This combination

suggests a strategic capability for handling both immediate disruptions and enduring transformations without significant performance losses. Moreover, health and safety management being grouped with these capabilities suggests an integrated approach to dynamic operational changes while ensuring employee safety and compliance with regulations. Cluster 2's capabilities, collaboration and risk orientation, suggest a strategic approach where entities focus on forming strategic alliances and emphasize proactive risk management. It suggests joint efforts to improve risk identification and mitigation, possibly through shared resources or information exchange. Cluster 3 presents a comprehensive set of capabilities, indicating multifaceted entities in their approach to supply chain management. Financial capability in this cluster suggests a strong foundation of financial power, enabling investments in supply chain reconfiguration and adopting digital transformation technologies. The presence of supply chain visibility and sustainability indicates a strategic priority on transparent operations and long-term environmental responsibility.

Table 34. Distribution of Supply Chain Capabilities Across Clusters for k=3

Cluster 1	Cluster 2	Cluster 3
Agility	Collaboration	Financial Capability
Health & Safety Management	Risk Orientation	Supply Chain Reconfiguration
Flexibility		Visibility
		Digital Transformation Capabilities
		Sustainability

Table 25 shows that when the cluster count is increased to four, a better segmentation of capabilities is observed. Cluster 1's focus on financial capability, flexibility, and supply chain visibility suggests a strategic emphasis on the financial management of resources and the adaptability to market volatility while ensuring operational transparency. Cluster 2, emphasising agility and sustainability, indicates an orientation towards rapid response to immediate changes while maintaining a commitment to environmental sustainability. This reflects a strategic balance between operational speed and ecological responsibility. Cluster 3 groups supply chain reconfiguration with collaboration and risk orientation, which could be characteristic of the fashion industry, where joint ventures or partnerships are essential for navigating complex supply chain transformations and shared risk environments. Cluster 4 comprises health and safety management and digital transformation capabilities, indicating a synergy between innovation and compliance-driven operations.

Table 35. Distribution of Supply Chain Capabilities Across Clusters for k=4

Cluster 1	Cluster 2	Cluster 3	Cluster 4
Financial Capability	Agility	Supply Chain Reconfiguration	Health & Safety Management
Flexibility	Sustainability	Collaboration	Digital Transformation Capabilities
Visibility		Risk Orientation	

As the number of cluster size increases to five, more discrete capability groupings are revealed, which is shown in Table 26. Cluster 1 combines supply chain reconfiguration with digital transformation capabilities, underscoring a progressive approach that leverages digital tools to enable structural adaptability in supply chains. This could indicate sectors undergoing digital disruption, where agility in reconfiguration is vital. Cluster 2's emphasis on agility and supply chain visibility suggests a grouping of capabilities that allow for quick response to changes and the maintenance of clear oversight across the supply chain. Cluster 3, with a focus on health and safety management and flexibility are likely to emphasize the well-being of their workforce while maintaining the ability to adjust their operations and strategies to meet long-term environmental uncertainties. This cluster may represent the change without compromising on safety and well-being, indicating a balanced approach to dynamic operational management. Cluster 4 shows financial capability and risk orientation together. This reflects a distinct strategy focusing on using financial resources to manage risks effectively, ensuring financial stability in the face of potential disruptions. Finally, Cluster 5 appear to place a strong emphasis on building strategic partnerships and focusing on environmental responsibility. The emphasis on sustainability suggests a commitment to eco-friendly practices and long-term environmental impact, while collaboration indicates a willingness to work with partners to achieve these goals.

Table 36. Distribution of Supply Chain Capabilities Across Clusters for k=5

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Supply Chain Reconfiguration	Agility	Health & Safety Management	Financial Capability	Collaboration
Digital Transformation Capabilities	Visibility	Flexibility	Risk Orientation	Sustainability

Additionally, the results indicate that, as the number of clusters increases, the dispersion and convergence of certain capabilities are observed. Notably, while flexibility and agility initially appear together, they are seen to diverge in higher k-values, suggesting that at a finer scale, companies may prioritize one over the other, pointing to a strategic choice between operational speed (agility) and the broader ability to manage change (flexibility). Similarly, as the number of clusters increases from three to five, certain capabilities, such as financial capability and supply chain visibility, initially clustered together, begin to separate, suggesting that as the analysis becomes more detailed, companies may be differentiating their strategies by focusing more intensely on specific aspects of their operations.

Moreover, it is revealed that clusters with overlapping capabilities such as digital transformation suggest a widespread recognition across the industry of its importance. Meanwhile, the separation of certain capabilities like financial capability and risk orientation in different clusters as k-values increase may indicate a more specialized strategic focus, as companies align their operations to distinct competitive advantages or market demands. This trend of separation and convergence of capabilities as the cluster number increases reveals the varying levels of priority that companies assign to different aspects of supply chain management, as well as the potential for more specialized focus areas within the industry.

CHAPTER 8: DISCUSSION

This thesis provides insights into how to build resilient supply chains specific to the fashion industry, enabling better decision-making under extreme conditions. The findings of this thesis have several important implications both for the theory and the practitioners. It suggests how to build a more resilient supply chain that can absorb shocks and continue operating in such conditions. Moreover, it provides insights into how relationships between suppliers, manufacturers, and retailers can be managed to create a resilient network which provides a comprehensive understanding of the interactions and dependencies between these tiers in the fashion supply chain, enabling us to shed light on how alterations in one tier could affect the rest.

8.1. Theoretical Implications

Implications of Dynamic Capabilities View

By applying DCV to the fashion supply chain, this study demonstrates the theory's foundational premises and expands its applicability. It shows how dynamic capabilities are critical for building resilience in extreme disruptions such as COVID-19 and the unique challenges of the fashion sector, such as rapid trend cycles, demand uncertainty, and the need for sustainable practices. This extension of DCV into the fashion supply chain context enriches our understanding of how industries characterized by high volatility and swift market changes, such as the fashion industry, can leverage dynamic capabilities for resilience and competitive advantage. In this regard, the supply chain capabilities revealed through the expert interviews can be examined through the lens of the three fundamental dynamic capabilities: *sensing*, *seizing*, and *reconfiguring*.

Firstly, the finding revealed that capabilities such as health and safety, supply chain visibility and sustainability enhance the *sensing* capability. Focusing on health and safety, especially in response to COVID-19, shows firms' ability to sense external threats (like a pandemic) and adapt their internal practices, resonating with DCV's emphasis on change. They recognized the critical nature of the pandemic and its potential to disrupt their operations extensively. Following, these firms' responses to the pandemic, such as implementing health and safety protocols and adapting workplace practices, demonstrate their ability to interpret and act on the information they sensed. By doing so, they could mitigate risks, protect their workforce, and maintain some level of operational continuity in a highly uncertain environment.

The findings revealed that supply chain visibility enhances a firm's *sensing* capabilities, allowing for better detection of external changes such as market demands and supply chain disruptions. Firstly, the findings on supply visibility align with the sensing aspect of DCV, as it empowers firms to quickly detect and interpret changes within their supply chain. For instance, if there's a disruption at a supplier's end, heightened supply visibility allows a firm to identify this issue promptly. This rapid detection is crucial for firms to adapt and respond effectively, mitigating potential impacts on their operations. Additionally, market visibility is directly related to the sensing capability in DCV. By thoroughly understanding the market, firms in the fashion industry can sense changes in consumer preferences and demand patterns. This sensing capability enables them to anticipate market shifts and adapt their strategies accordingly. For example, the shift towards online shopping during the pandemic required firms to sense this trend and adapt their sales and distribution channels to meet this new consumer behavior.

Furthermore, regarding sustainability, the findings indicate that fashion companies are increasingly aware of the growing consumer demand for sustainable products. The sensing capability here involves recognizing these changing consumer preferences and market trends. Firms should be aligned with these shifts, understanding the importance of consumers' preference for eco-friendly and ethically sourced products. Findings also emphasize the importance of staying updated with regulatory changes. Sensing includes being vigilant about environmental legislation and standards that impact the fashion supply chain. This could involve understanding the implications of regulations on waste management, emissions, and ethical labor practices and how they affect the business. In addition to external sensing, findings suggest that firms in the fashion supply chain are assessing their internal processes to identify opportunities for integrating sustainable practices. This internal sensing includes evaluating the supply chain's environmental footprint and identifying areas for improvement, such as reducing waste, using sustainable materials, or improving energy efficiency in manufacturing processes. However, it should be noted that while DCV traditionally emphasizes external sensing (market trends and consumer behavior), this thesis suggests a more balanced approach where internal sensing (operational efficiency, employee capabilities) is equally crucial. This could indicate a slight shift or expansion in the DCV's traditional focus, adapting it more comprehensively to the complexities of the modern fashion industry.

Secondly, the digital transformation capability, collaboration, fleet flexibility and sustainability exemplify the *seizing* mechanisms of DCV. Firms in the fashion industry are leveraging these technologies not only to adapt to market demands but also to seize new opportunities for efficiency and innovation. The adoption of e-commerce platforms, AI, and other digital technologies illustrates seizing opportunities through innovation, a key aspect of the seizing mechanism in DCV. Furthermore, the focus on collaboration and partnerships found in this thesis is a way of seizing opportunities by pooling resources and capabilities to enhance overall supply chain resilience. Unlike traditional DCV, which may focus more on internal resource reallocation, this thesis highlights the importance of external collaborations and networks in seizing market opportunities. This could indicate an evolution in the seizing aspect of DCV, where external collaborations are as critical as internal strategic decisions.

In addition, fleet flexibility in the fashion supply chain aligns with the seizing mechanism by enabling firms to respond adaptively to the rapidly changing logistics and transportation demands posed by the pandemic. The pandemic's unique challenges, such as lockdowns and disrupted transportation networks, necessitated quick adaptation in logistics strategies. Firms that demonstrated this flexibility, like those using different modes of transport to circumvent disruptions (such as the Suez Canal blockage), were effectively seizing opportunities to maintain supply chain fluidity. By diversifying their transportation methods, these companies could maintain supply chain continuity despite external disruptions.

Additionally, upon sensing the external and internal cues related to sustainability, the selected companies in this thesis are seen to take proactive steps to incorporate these practices. This may involve transitioning to sustainable materials, adopting eco-friendly manufacturing processes, or forming partnerships with suppliers who adhere to ethical and environmental standards. Moreover, seizing opportunities in the context of sustainability, as revealed in this thesis, also involves strategic decision-making and investments such as allocating resources towards sustainable product development, changing supply chain strategies to ensure ethical sourcing, or investing in technologies that reduce environmental impact. The interviews revealed that, even though trends are changing for more sustainable approaches, such as the use of eco-friendly materials, there is only sensing and seizing, but there is no reconfiguration. The reason behind the lack of sustainability reconfiguration in supply

chains was associated with economic, bureaucratic, and educational barriers, according to the interview findings. On the other hand, according to the news content analysis, there is also reconfiguration along with sensing and seizing sustainable approaches.

Thirdly, capabilities such as agility, capacity flexibility, manufacturing flexibility, collaboration, digital transformation capabilities, risk orientation, and sustainability align with the *reconfiguration* concept. The agility of fashion supply chains in response to the COVID-19 pandemic shows how selected firms can effectively reconfigure their operational strategies and resource allocations to maintain resilience and competitive advantage in a rapidly changing environment. This aligns with DCV's emphasis on dynamically adapting to environmental changes through strategic and resource-based transformations. The pivot to mask production was a direct response to the sudden increase in demand for personal protective equipment (PPE) due to the pandemic. This demonstrates the companies' ability to sense market needs and reconfigure their operations to seize these new opportunities.

Building capacity flexibility by adjusting production/service levels to meet demand changes also reflects the DCV's reconfiguration aspect. For instance, one of the yarn manufacturers adjusted their production levels in response to the fluctuating demand during the pandemic. Initially facing a demand crisis due to order cancellations, they adapted by revising their production capacity to align with the new market realities. This adjustment in production capacity is a clear example of reconfiguring. It reflects the firm's ability to modify its operational capabilities – in this case, production volume – to effectively respond to rapid changes in demand. This strategic adaptation demonstrates how companies in the fashion supply chain effectively reconfigure their resources and capacities to manage external disruptions, aligning with the DCV's emphasis on the dynamic adjustment of operational capabilities.

Moreover, collaboration in the fashion supply chain, especially in times of crisis, shows firms' ability to build and reconfigure external competencies which is in line with the foundational aspect of DCV. For instance, the joint-problem solving approach adopted by a cotton manufacturer firm in response to the global increase in paper prices is a significant example. This company worked in collaboration with packaging material suppliers to develop solutions that would mitigate the impact of rising costs and material shortages. This adaptive strategy of modifying their external

relationships and resources – in this case, through supplier collaboration – to manage supply chain disruptions is a clear manifestation of reconfiguring competencies. Another instance is the collaborative efforts in logistics flexibility, where one of the selected companies partnered with logistics firms to adapt their distribution strategies during the pandemic. These partnerships allowed more effective management of increased e-commerce demand and changing delivery preferences. By reconfiguring their logistics processes and external collaborations, these companies exemplified the DCV premise of dynamically adjusting competencies to maintain supply chain resilience.

Another example from the findings that embodies the reconfiguring aspect of the DCV is the fashion supply chain's shift towards enhanced digital transformation capabilities. With the onset of the pandemic and the closure of physical retail stores, many fashion companies rapidly transitioned to or bolstered their e-commerce platforms. This shift required not only technical infrastructure changes but also a rethinking of marketing, sales, and distribution strategies to align with an online retail model. Moreover, integrating AI and data analytics for forecasting and promotion purposes represents a significant reconfiguration of how fashion companies predict consumer behavior and manage inventory. This technological adoption signifies a transformation from traditional, more intuitive approaches to data-driven decision-making. The investment in AR, VR, and 3D modelling technologies to showcase products and facilitate remote interaction with customers also illustrates a fundamental change in how products are presented and marketed. Each of these examples demonstrates reconfiguring resources and operational models, which aligns with DCV's premises. They represent not just temporary adjustments but fundamental changes in how fashion supply chains operate, highlighting a strategic transformation to maintain resilience and competitiveness in the face of the disruptive external environment caused by the pandemic.

Moreover, a cotton supplier's investment in solar power systems post-Covid signifies a strategic shift and reconfiguration of the company's resource base to embrace renewable energy. Such a shift demonstrates a dynamic capability as per DCV, where the firm is adapting to external environmental pressures and proactively modifying its operational practices and infrastructure towards sustainability. Additionally, establishing risk committees indicates reconfiguring organizational structures and processes to address and manage potential risks more effectively.

On the other hand, sourcing flexibility, particularly seen in diversifying suppliers and engaging in multi-sourcing strategies, resonates with all three aspects of DCV. By diversifying their supply base, firms were sensing potential risks in supply chain disruptions and preparing to seize alternative sourcing opportunities. Multi-sourcing, in particular, is a strategic reconfiguration of the supply chain to enhance resilience and mitigate risks.

Furthermore, while the implications drawn from the DCV provide a subtle understanding of the fashion supply chain's adaptive mechanisms, it is also important to consider how these insights align with or diverge from, the findings of previous studies in this domain. In this regard, the results of this thesis corroborate Teece's (2018) assertion that dynamic capabilities are essential for sustainable competitive advantage. The agility and flexibility highlighted as pivotal by the interviewees in navigating the pandemic-induced disruptions reflect the DCV's emphasis on adaptive strategic moves. Similar to Wu et al. (2006), this research demonstrates that dynamic capabilities within the supply chain are a fundamental cornerstone in sustaining operational performance amidst external disruptions. The strategic shifts to digital platforms, as reported by companies during the COVID-19 pandemic, exemplify the kind of rapid resource reconfiguration that DCV posits as critical for maintaining competitiveness. Moreover, this is in harmony with Zhou and Wu's (2010) findings that supply chain agility, enhanced by dynamic capabilities, can significantly improve firm performance. Additionally, the collaborative efforts for problem-solving and co-value creation mentioned by respondents echo Brandon-Jones et al. (2014).

In summary, the DCV provides a robust theoretical framework to understand how firms in the fashion industry are developing and adapting their supply chain capabilities. The industry's fast-paced nature necessitates a dynamic approach to managing resources and capabilities, and the DCV theory offers valuable insights into how firms can navigate this complex environment. The unique challenges and dynamics of the fashion industry provide a rich context to explore the practical applications of DCV, especially in terms of sensing market trends, seizing new opportunities through innovative practices, and reconfiguring resources to maintain competitiveness in a rapidly evolving environment. This analysis not only substantiates the foundational aspects of DCV but also extends its applicability, showing its relevance in addressing contemporary challenges in the fashion industry's supply chain resilience. Overall, the findings of this thesis demonstrate how each

capability, whether it's adapting to sustainability standards, managing risks proactively, embracing digital transformation, or ensuring flexibility and agility, aligns with the DCV's premises. Moreover, the alignment of this thesis's findings with the DCV premises highlights the relevance of this theory in understanding the evolving nature of supply chain management in the fashion industry.

Implications of Resource Orchestration Theory

The theoretical implications drawn from this thesis suggest that ROT provides a robust framework for understanding how fashion companies have navigated the pandemic by strategically managing their resources. This orchestration has proven essential for adapting to market fluctuations, enhancing supply chain resilience, and transitioning towards more sustainable practices. The findings highlight the importance of a subtle approach to resource orchestration to thrive in the highly competitive and ever-evolving fashion industry.

Structuring, Bundling, and Leveraging:

Structuring in the context of the fashion supply chain involves decisions about investments in sustainable materials, advanced technologies, and partnerships. The findings of this thesis reveal that fashion companies have had to swiftly restructure their supply chains during the pandemic, reflecting ROT's emphasis on strategic resource alignment highlighted by Hughes et al. (2018). The findings indicate that companies are structuring their resources towards more sustainable and technologically advanced solutions. This aligns with the ROT premise that efficient structuring of resources sets the stage for their effective utilization. For instance, most of the companies emphasized the need for digitalization in response to the pandemic. This necessitated a restructuring of their resource base, shifting focus from traditional retail strategies to enhancing their online platforms and e-commerce capabilities. This transition involved investing in digital infrastructure, such as upgrading their website, implementing more sophisticated online payment systems, and enhancing their digital marketing strategies. This strategic move is a clear example of structuring in line with the ROT. The company recognized the necessity of digital resources in the new market environment and strategically reallocated its resources towards building a robust digital presence. This adaptation was not just about acquiring new technologies but also involved divesting from some of their existing physical retail resources, reflecting a deliberate and strategic restructuring of resources to remain competitive and resilient in the face of changing market conditions. Similarly, the findings also revealed that

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companies have been actively investing in and acquiring digital technologies like AI, AR/VR, and 3D modelling. This indicates a deliberate structuring of technological resources to enhance operational efficiency and adapt to market shifts.

The findings further suggest that the fashion industry's move towards sustainability and circularity requires a deliberate orchestration of resources, as indicated by Saccani, Bressanelli, and Visintin. (2023). Companies are increasingly accumulating resources that align with sustainability goals, such as eco-friendly materials and renewable energy sources. This aligns with structuring resources to comply with global sustainability standards and meet consumer preferences for environmentally responsible products. Moreover, investments in solar energy and the adoption of sustainable materials indicate the industry's resource structuring towards a circular economy, highlighting the significance of ROT in navigating this transition. Additionally, in response to COVID-19, companies have had to rapidly adapt and enhance their health and safety protocols. This involves structuring resources towards developing and implementing new health guidelines and safety measures.

The bundling of resources in the fashion supply chain is reflected in the integration of technological, economic, and environmental resources to form robust capabilities. For instance, combining digital transformation tools with eco-friendly practices exemplifies bundling different resources to create a competitive edge. This aligns with ROT, where bundling involves synergizing resources for greater value. The fashion industry's move towards digital fashion shows and online platforms represents this bundling process, integrating digital capabilities with traditional fashion industry practices. Moreover, the use of AI and big data analytics in supply chain management is another example of bundling. The findings revealed that some of the companies have integrated AI algorithms with their existing data collection systems to gain deeper insights into market trends, consumer behaviors, and supply chain dynamics. This approach allows for more accurate forecasting and better decision-making in areas like inventory management and product development.

Furthermore, some companies have bundled their internal capabilities with external partnerships to enhance collaboration. This includes the use of collaborative approaches for joint problem-solving with suppliers, logistics providers, and other partners. For instance, a cotton manufacturer firm adopted a collaborative approach to address the global increase in paper prices. This involved a close partnership with their packaging material suppliers. By jointly addressing the issue, they were able to

mitigate the impact of rising costs on their supply chain. Another example illustrates a retailer working closely with a logistics firm and establishing agreements with courier services to prioritize fast delivery. This initiative, which integrates the company's logistics strategy with external partners, exemplifies collaborative bundling for enhanced supply chain efficiency. These alliances have been instrumental in maintaining a stable supply chain and underline the importance of shared goals and visions in building resilience, as suggested by ROT.

In addition, the integration of supply chain visibility tools with operational practices is another example of bundling. Findings revealed that companies are using real-time tracking systems, advanced analytics, and IoT devices to gain comprehensive visibility into their supply chains. This integration enables them to monitor supply chain performance, anticipate potential disruptions, and respond proactively. Some companies have integrated systems that allow for continuous monitoring of supply chain activities. This includes tracking shipments, inventory levels, and production schedules, thereby enhancing the ability to promptly anticipate and respond to disruptions. Some companies have employed advanced analytics tools to gain deeper insights into market demands and supply chain dynamics. These tools are used to analyze data from various sources, helping understand consumer behavior, market trends, and supply chain vulnerabilities.

Findings revealed that many companies enhanced their e-commerce capabilities in response to the pandemic. This shift to online retail required leveraging digital and IT resources to meet the increase in online shopping demand. *Leveraging* these bundled resources is evident in how fashion companies utilize their digital and sustainable capabilities to adapt to market changes and consumer demands. Applying digital technologies in real-time monitoring and adopting sustainable practices in response to environmental regulations demonstrate effective leveraging. This resonates with ROT's emphasis on extracting maximum value from resource bundles.

Additionally, with the COVID-19 pandemic, companies invested in health and safety measures within their operations. This required leveraging human resource capabilities, technology, and physical infrastructure to ensure safe working conditions, which was crucial for maintaining operational continuity. Moreover, firms showed agility by quickly adapting their supply chains to new conditions. This involved leveraging their logistical, manufacturing, and supplier network capabilities to ensure continuity in operations. For instance, companies that switched to producing masks or

other pandemic-related products demonstrated leveraging their manufacturing capabilities and supply networks to meet new market demands. Findings revealed that leveraging financial resources effectively was also crucial, especially in managing the economic impacts of the pandemic. This included optimizing cash flows, securing additional funding where necessary, and making strategic investments in areas like digital transformation and sustainability to ensure long-term resilience.

Furthermore, findings demonstrated that some companies focused on integrating sustainable practices into their operations. This involved leveraging resources like eco-friendly materials, renewable energy sources, and sustainable manufacturing processes to align with global sustainability standards and consumer preferences. However, while ROT emphasizes the smooth integration and application of resources, the fashion industry faces complexities in execution. Monetary constraints and rapidly changing market dynamics present challenges in seamlessly *bundling* and *leveraging* resources.

Breadth, Depth, and Life Cycle:

Breadth in ROT concerns how a firm's resources are structured, bundled, and leveraged across the entire scope of the firm (Sirmon, Hitt and Ireland, 2007, Sirmon et al., 2011). Findings revealed that companies in the fashion industry expanded their digital footprint across multiple departments. This broad application of digital resources signifies a strategic vision encompassing various operational areas, from marketing to supply chain logistics. Moreover, implementing sustainability measures across the firm, from sourcing to production and distribution, demonstrates a broad, integrated approach. This strategic choice reflects planned proactivity in aligning the company's entire operations with sustainability goals. Additionally, reconfiguring the supply chain, such as diversifying sources and reducing dependency on single regions, is another example of breadth. This strategy was not confined to a single operational area but spanned across procurement, production, and distribution, reflecting a holistic approach.

Depth in ROT concerns managing and orchestrating resources across different levels of the firm's hierarchy (Sirmon, Hitt and Ireland, 2007, Sirmon et al., 2011). In this regard, the integration of risk orientation capability across all levels of the organization exemplifies the depth concept. This ranges from strategic decisions by top management to adaptations at the operational level, reflecting a comprehensive approach to risk management. Moreover, implementing health and safety protocols

required coordination across different levels of management. This shows an understanding and implementation of health and safety measures from corporate policy-making to day-to-day operations. Additionally, managing financial resources effectively, especially during the pandemic, involved decisions and actions at various levels. Strategic financial planning by top executives, operational budget adjustments, and tactical financial manoeuvres at the ground level all showcase the depth of financial resource orchestration.

Although ROT suggests uniform resource orchestration across various levels and functions of an organization, in practice, the depth and breadth can be inconsistent. For instance, the interviews revealed a significant focus on the digital transformation aspect of supply chain capabilities. However, other critical areas like sustainable practices are not equally emphasized. Despite the growing importance of sustainability in the fashion industry, there is less evidence of comprehensive strategies to integrate sustainable practices throughout the supply chain. This inconsistency in the depth and breadth of resource orchestration, where technological advancements overshadow efforts in environmental sustainability, demonstrates a divergence from ROT's principles. It highlights a potential area for further development in aligning resource orchestration strategies with the holistic needs of the fashion industry.

Overall, the findings of this thesis show a significant alignment with the ROT framework. The industry's approach to managing resources -structuring, bundling, and leveraging them- across breadth, depth, and life cycle dimensions—highlights ROT's applicability in understanding and optimizing the strategic management of resources in the dynamic fashion market.

Implications of Complex Adaptive Systems

CAS, when applied to the findings of this thesis, provides a subtle understanding of how the fashion supply chain's multifaceted and interconnected nature contributed to resilience during the pandemic. This thesis suggests that the fashion supply chain, characterized by its multiple *agents* (manufacturers, retailers, and consumers) and their interdependencies, exemplifies a CAS where *emergent behaviours* and *self-organization* are evident in response to external shocks.

Considering agents as different stakeholders, including suppliers, manufacturers, and retailers in the context of fashion supply chains, each agent operates with its own set of norms and values, impacting the overall supply chain dynamics. For instance, technological advancements such as digital archiving and

visualization of products as identified in the findings, exemplify how *agents* (companies) adapt their *schemas* (strategies and technologies) in response to environmental shifts, such as market demand and digitalization trends. Similarly, some firms' transition to mask production by some firms during the COVID-19 pandemic reflects their ability to adjust strategies based on environmental cues rapidly. This further exemplifies agents following schemas in response to market needs.

As observed in this thesis, the supply chain capabilities of firms to reconfigure supply chains mirror the adaptive traits of CAS outlined by Choi, Dooley, and Rungtusanatham (2001). The agility fashion companies show to pivot operations, diversify supply sources, and leverage digital transformation exemplifies the *self-organizing* nature of CAS and its propensity for emergent, innovative solutions in the face of disruptions. Moreover, the findings demonstrated that fashion supply chains exhibit self-organization, especially in their collaborative efforts. Joint problem-solving initiatives, as seen in response to the paper price increase by a cotton manufacturer, are indicative of emergent behavior arising from individual company actions, aligning with the principles of CAS.

The complex *network of connections* in CAS is mirrored by the interplay between various entities in the fashion supply chain. The complex network of suppliers, manufacturers, and retailers in the fashion industry, as evidenced in the supply chain reconfiguration strategies, shows the critical role of connectivity. This interconnectedness has led to emergent phenomena, such as rapid shifts in production priorities in response to market changes. Findings revealed that companies reconfigured their supply chains as a response to disruptions. This involved establishing new partnerships and revising logistics strategies, which inherently increased the connectivity between various supply chain actors. Reconfiguration efforts aimed at diversifying suppliers or adopting multi-sourcing strategies, for instance, expanded the network of connections within the supply chain, making it more robust and adaptable. Moreover, the results of this thesis indicate that companies shifted production to meet new demands, like the manufacture of face masks using available materials, emphasizing the CAS principle of connectivity and dimensionality.

The fashion industry's supply chain operates in a *dynamic* environment characterized by constant shifts in consumer preferences, rapid technological advancements, and a spectrum of global disruptions. This includes the profound

impact of the COVID-19 pandemic, which has caused several domino effects, and other disruptions such as the Suez Canal crisis, the Russia-Ukraine war, etc.. Additionally, financial instabilities like the Turkish currency and debt crisis have further complicated financial and strategic planning. Companies have responded to these challenges by adopting several capabilities to enhance resilience and adaptability. Fashion companies also navigate a *rugged* landscape, dealing with fluctuating market demands, evolving regulatory pressures, and environmental sustainability concerns. The focus on sustainability revealed in the findings, including investments in eco-friendly materials and practices, demonstrates their navigation through this complex landscape.

Additionally, the fashion industry and its environment *co-evolve*, as seen in the adaptation of health and safety management in response to COVID-19. The pandemic has led to a mutual adaptation of the industry and its operating environment, with companies evolving their practices in line with changing health guidelines and consumer expectations. Moreover, the collaborative efforts within the industry to navigate the pandemic, involving joint problem-solving and shared financial risks, reflect the CAS concept of co-evolution. The fashion supply chain and its environment co-evolved as firms and their external partners adapted their strategies and resources in tandem, highlighting the bidirectional relationship between systems and their environments.

The *non-linear* nature of CAS, where small changes can have disproportionate impacts, is observed in how minor disruptions can escalate rapidly within the interconnected fashion supply chain. The industry operates in a *quasi-equilibrium* state, balancing between stability and adaptability, which was particularly challenging during the pandemic, pushing companies to reevaluate and adjust their strategies. The fashion industry's movement towards more sustainable practices and increased digitalization can be seen as a state change, a key characteristic of CAS. This suggests that while the fashion supply chain may strive for balance, it is always on the verge of transformation, ready to adapt to significant shifts. The findings of this thesis also resonate with the non-linear changes inherent in CAS. Adopting such capabilities, like enhancing e-commerce capabilities or adopting digital archiving, had large-scale impacts on companies' resilience.

The fashion industry's supply chains adapt and evolve continuously in response to external and internal changes, much like agents in a CAS. The shift towards digital

transformation and sustainability in fashion supply chains can be seen as emergent behaviors of the system, responses to external pressures, similar to the emergent phenomena in CAS. However, CAS suggests that future behavior, though not entirely random, is difficult to predict precisely, yet the findings indicate a significant focus on predictive analytics and advanced technologies to anticipate and manage future disruptions. This emphasis on predictability and control through technological advancements presents a subtle interpretation of CAS in the context of modern supply chain management.

In conclusion, the theoretical implications drawn from this thesis suggest that the CAS framework provides a valuable lens for understanding the intricate and evolving nature of the fashion supply chain. The theory sheds light on how individual agents within the supply chain interact to produce emergent behaviours, leading to the system's adaptation and co-evolution with its environment. This understanding can guide managers and policymakers in the fashion industry to foster resilience by embracing the principles of CAS, particularly the capacity for self-organization, responsiveness to environmental dynamism, and the potential for co-evolutionary growth.

Implications of the Quantitative Study

The quantitative study contributes to the theory by offering empirical evidence on how distinct capabilities influence business resilience and adaptability. The company clustering analysis in the quantitative study offers profound theoretical implications. It interprets the heterogeneity in strategic orientations among fashion firms, underlining the necessity for diverse business models. This diversity reflects the complex interplay between market demands, technological advancements, and organizational capabilities. The study thereby contributes to the academic discourse on strategic management, particularly in how organizations adapt and differentiate themselves in rapidly changing industries.

In contrast, the capability clustering analysis provides crucial insights into the interdependencies and synergies among various supply chain capabilities. It emphasizes the multifaceted nature of supply chain management, where capabilities such as agility, digital integration, and sustainability are not isolated but interact dynamically. This analysis enriches theoretical understandings in the field of supply chain management, highlighting the nuanced ways in which companies balance and leverage different capabilities to achieve competitive advantage and resilience in a

volatile market environment.

This contribution is valuable for developing new or enhancing existing theories in organizational strategy and supply chain management. It provides a grounded basis for theorizing about the practical implications of different supply chain strategies in the dynamic fashion industry, potentially inspiring future research to explore these relationships further.

Last but not least, building upon the valuable insights of previous research, this thesis introduces a novel mixed-method research design, employing qualitative data from semi-structured expert interviews to enrich our understanding of supply chain resilience. Additionally, our research diverges from existing studies on clustering models in a supply chain resilience context, such as Rajesh (2018), Wen and Liao (2021), Cabral, Grilo and Cruz-Machado (2012), and Jabbarzadeh, Fahimnia, and Sabouhi (2018), by providing utilization of qualitative data from semi-structured expert interviews into the mathematical model, which enables a richer, more comprehensive exploration of resilience capabilities within supply chains. This approach not only acknowledges the complexities and interdependencies inherent in supply chains but also offers new perspectives and solutions, enhancing the theoretical and practical understanding of supply chain resilience.

8.2. Managerial Implications

The findings of this research present a comprehensive understanding of the fashion supply chain's resilience to severe disruptions, particularly those of an extreme nature like the COVID-19 pandemic. Such disruptions highlight the critical need for managerial foresight and strategic agility. Managers within the fashion industry are now faced with the challenge of understanding these complex dynamics and crafting resilient frameworks that can withstand and adapt to such unprecedented shocks.

The results of this thesis indicate that managerial implications from the recent disruptions point toward the necessity for developing various supply chain capabilities in the dynamic landscape of the fashion industry. First, firms' health and safety capability is increasingly crucial, especially in light of the COVID-19 pandemic. Effective health and safety management can protect the workforce and ensure uninterrupted operations. Managers should prioritize robust health protocols, invest in safety training, and incorporate health considerations into every supply chain decision. In addition, fashion companies should integrate strategic agility into their core operations, enabling quick responses to market fluctuations and unforeseen events.

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This includes reassessing and reconfiguring supply chains to minimize dependency on single sources and geographical risks. Moreover, the necessity for resilience has moved to the forefront, calling for managers to invest in flexible production capabilities and diversified sourcing strategies. The pandemic has also highlighted the importance of financial capability, emphasizing the need for firms to maintain liquidity and flexibility in financial operations. This can involve renegotiating contract terms, diversifying payment options, and maintaining transparent financial communications with supply chain partners. Furthermore, collaborative efforts have proven essential for resilience, as firms benefit from shared resources, joint problem-solving, and co-innovation. Establishing new partnerships and strengthening existing ones ensures a unified front when facing supply chain challenges.

In addition, the crucial role of digital transformation has been emphasized, as it facilitates risk forecasting and demand management and enhances operational efficiency. The acceleration towards e-commerce, driven by a shift in consumer behaviour, necessitates a robust digital transformation strategy. Therefore, managers need to prioritize strengthening their e-commerce platforms, enhancing online customer experiences, and optimizing their digital supply chains to ensure seamless integration with physical operations. Investments in e-commerce, process automation, data analytics, and advanced digital technologies such as AR, VR, and 3D modelling have become imperative across the fashion industry. These technologies not only aid in meeting the rapid shift to online retail but also support sustainable practices by providing end-to-end visibility and traceability across the supply chain.

Furthermore, the fashion supply chain has a growing consumer demand for sustainable practices. Managers should invest in sustainable production methods, including renewable energy sources, and support initiatives such as the U.S. Cotton Trust Protocol, which aims to reduce greenhouse gas emissions and promote ethical labour practices. Considering such environmental concerns and evolving consumer expectations, the transition towards a circular economy is becoming increasingly relevant. This requires companies to innovate and adopt new business models that prioritize the longevity and recyclability of products, aiming to reduce waste and environmental impact.

With the COVID-19 pandemic, it has become clear that traditional supply chain mechanisms are insufficient to cope with the magnitude of disruptions observed. It has exposed the vulnerabilities of globalized supply chains, signalling the need for

a more strategic approach to sourcing. Managers should consider the ethical implications of their sourcing decisions, particularly in light of events like the Xinjiang cotton ban, which has raised significant ethical and operational questions. There is an urgent need for transparent sourcing practices that align with international labour and human rights standards. This might involve re-evaluating supplier relationships, considering nearshoring or reshoring certain operations, and investing in supply chain traceability technologies. Labour shortages and strikes have also brought to the fore the importance of ethical labour practices and the need for collaborative efforts in ensuring a resilient supply chain. Managers are suggested to engage in meaningful dialogue with labour unions, initiate improvements in worker conditions, and adopt fair labour practices. Such actions are not only ethically sound but also mitigate the risks associated with labour unrest and its impact on production timelines.

Moreover, the geopolitical tensions and economic instabilities, exemplified by the Russia-Ukraine war and the devaluation of the Turkish Lira, further complicate the landscape. These factors underscore the importance of geopolitical awareness in building resilient supply chains. Managers should develop a keen understanding of global economic trends and political risks to navigate these challenges proactively. This includes reassessing the company's financial hedging strategies and considering the impacts of currency fluctuations on pricing and profitability. Nevertheless, the environmental crises, particularly global warming and wildfires, have had a tangible impact on the fashion supply chain, affecting raw material sourcing and logistics. Managers are now expected to consider the environmental footprint of their supply chain operations and incorporate sustainable practices into their business models. This might involve embracing the principles of the circular economy, investing in sustainable materials, and adopting manufacturing processes that are less damaging to the environment.

Barriers and Implications:

The results of this thesis have revealed economic, bureaucratic, and educational barriers to implementing resilient and sustainable supply chains, which have significant implications for managers in the fashion industry. Firstly, a strategic shift in financial planning is essential to overcome financial challenges while building resilient supply chains. Fashion companies should balance the immediate economic pressures with the long-term benefits of sustainable practices. This involves carefully analysing the costs and benefits associated with sustainability investments and

exploring alternative financing options such as government grants or sustainability-linked loans. Such measures can alleviate the financial strain and enable companies to invest in resilient supply chain strategies.

Secondly, the bureaucratic barriers necessitate active engagement in policy advocacy. Fashion companies should strive for a stable and predictable regulatory environment, which can be achieved through collaboration with industry associations and other stakeholders. This collective effort can help shape favourable policies for building resilient supply chains.

Last but not least, educational barriers cause a unique challenge, requiring significant investment in training and development. The industry's professionals and stakeholders need to be equipped with the necessary knowledge and expertise, particularly in areas like carbon emission calculations and sustainable supply chain practices. Companies should focus on building awareness and know-how about the importance of resilience in supply chains among their employees and suppliers. Furthermore, consumer education plays a pivotal role, too. Companies can support a shift towards more conscious consumption and sustainable fashion practices by engaging in initiatives that alter consumer perceptions and habits.

In a broader strategic context, integrating sustainability and resilience into the core business strategy is crucial. This integration requires a shift in mindset at both the corporate and individual levels, viewing sustainability as an essential part of the business model rather than a peripheral concern. Additionally, developing a collaborative ecosystem with suppliers and other stakeholders is critical. This unified approach can enhance the overall resilience of the supply chain. Leveraging technological innovations and digital transformation can also help overcome some of the identified barriers.

Overall, building resilient fashion supply chains in the face of these identified barriers is a complex but essential task. It requires a subtle approach involving strategic financial planning, policy advocacy, educational initiatives, and a commitment to long-term sustainability goals. By addressing these barriers comprehensively, fashion companies can enhance their resilience and contribute significantly to a more sustainable and ethically responsible industry.

Implications of the Quantitative Study

Additionally, the findings of the quantitative study highlight the importance of strategic grouping in fashion companies, focusing on enhancing supply chain

capabilities. The results indicate that companies can improve their resilience by aligning supply chain strategies with business objectives. This approach is particularly crucial in the highly dynamic and competitive fashion industry, where market trends and consumer demand constantly evolve.

Firstly, results on company and capability clustering in the fashion industry reveal detailed insights. For company-capability interactions, the study identifies resilience capability profiles among fashion companies, focusing on different resilience capabilities in the sector, leading to varied company profiles. While capabilities such as flexibility, agility, and digital transformation, are well-recognized by fashion companies, the lack of emphasis on health and safety management, sustainability, and risk orientation is notable. In the context of escalating climate change challenges and an increasing number of global disruptions, these capabilities are crucial. Companies need to integrate these aspects into their strategies proactively. Prioritizing sustainability and risk orientation is not only essential for resilience in the face of environmental changes but also critical for long-term business sustainability and adapting to a rapidly evolving global landscape. Moreover, managers should consider how integrating different capabilities can lead to more resilient supply chains, especially in response to disruptive events. The diversity in clustering suggests that a one-size-fits-all approach to supply chain management is ineffective. Managers should tailor their strategies to align with their company's specific combination of capabilities.

Secondly, the capability clustering reveals specific combinations that are frequently utilized together in the fashion industry. The interrelations between supply chain capabilities reflect strategic considerations within the fashion industry. For instance, grouping health and safety management with flexibility indicates an integrated approach to dynamic change while ensuring workforce safety. Similarly, the frequent pairing of digital transformation with supply chain reconfiguration suggests a focus on leveraging technology to enhance resilience. Additionally, the repeated clustering of risk orientation with collaboration implies joint efforts in risk management, potentially through shared resources or collective strategies. These examples demonstrate how different capabilities are strategically combined to address specific market needs and competitive dynamics in the fashion industry. Moreover, this highlights the fashion industry's recognition of the need to combine various capabilities to address market demands and enhance supply chain resilience effectively. Managers should note these pairings as indicative of the integrated

approaches needed to navigate the complexities of the modern business environment, enhancing competitive advantage and ensuring sustainability in a volatile world.

Last but not least, the toolbox mode applied in this quantitative study, which explores different clustering possibilities (e.g., k=3, 4, 5), allows for a more comprehensive analysis of how different clusters emerge and change with varying parameters. Through the toolbox approach, we observed various scenarios which helped us examine resilience capability profiles more closely. Despite varying the parameter 'k' for the company clustering model, in each instance, the results showed that companies generally understand resilience capabilities like flexibility, agility, digital transformation, and visibility. Yet, they are less engaged with capabilities such as health and safety management, risk orientation, and sustainability. Therefore, the toolbox approach demonstrated the importance of flexible modeling in capturing the complexity of supply chain capabilities in the fashion industry, providing a more dynamic and detailed understanding of capability combinations and company profiles.

8.3. Limitations and Future Research

While this thesis has contributed valuable insights into the effects of extreme disruptions on fashion supply chains, as well as the implementation of supply chain capabilities, it is essential to acknowledge certain limitations.

One of the primary limitations is the data collection methodology. Our study advances the understanding of fashion supply chain resilience through a dual-method approach, combining in-depth semi-structured expert interviews with comprehensive news content analysis of online sources. While this methodology has enabled us to extract valuable insights from industry experts and capture a broad perspective from media coverage, enriching our multifaceted understanding of the subject, it has limitations: Expert interviews, while insightful, and news analysis, though wide-ranging, may not completely capture the full spectrum of experiences and viewpoints of all supply chain participants, particularly the emotional nuances and practical challenges in their daily operations. Future research could build on our robust foundation by integrating additional methods such as large-scale surveys and statistical evaluations for a more comprehensive industry-wide view and conducting detailed case studies and practical experiments in collaboration with supply chain members to explore more into the operational realities of supply chain resilience. Such an expanded methodological scope can enrich future studies, offering a more thorough and applicable exploration into the complexities of fashion supply chain resilience.

In addition to the above recommendations, it is essential to consider the applicability of this research framework to industries beyond fashion. The dynamics of supply chain resilience, while explored in depth within the fashion industry context, hold potential insights for other sectors. Industries such as automotive, electronics, healthcare, and consumer goods, each with its distinct supply chain challenges and operational nuances, could greatly benefit from similar studies. By applying this research to various industries, future studies could uncover industry-specific supply chain capabilities to build supply chain resilience. Such a cross-industry approach would enhance the external validity of the current study's findings and contribute to a more robust and versatile understanding of resilience across different market environments and challenges. Moreover, future research should consider applying and testing the clustering model across diverse industries too. This could also validate the model's applicability and robustness, potentially necessitating adaptations to accommodate sector-specific dynamics. Extending the model's application would offer a comprehensive understanding of its versatility and limitations, providing a robust cross-industry supply chain analysis framework.

Furthermore, while the present study provides comprehensive insights into the resilience strategies of fashion supply chains in the face of extreme disruptions, a notable area for future research emerges in exploring the *life cycle* aspect of ROT. Future studies could focus on how fashion companies at different stages of their organizational life cycle - from startups to mature enterprises - uniquely structure, bundle, and leverage their resources in response to industry disruptions and evolving market demands. It would offer subtle perspectives on strategic resource orchestration, contributing to both theoretical development in ROT and practical applications in supply chain management. This inquiry could reveal critical insights into the lifecycle-specific challenges and opportunities in the fashion industry, providing a roadmap for tailored resilience strategies across different stages of organizational growth and evolution.

Lastly, while the fashion companies in the sample operate within global supply chains, it should be noted that the majority of these companies' primary operations are located in Turkey. This geographic concentration is a critical factor to consider when evaluating the findings of this thesis, as it presents unique insights into the challenges and strategies specific to developing countries. Therefore, while this thesis offers valuable contributions to the understanding of fashion supply chain resilience, the

results should be interpreted with an awareness of the geographical context. Future studies could benefit from expanding the scope to include a more diverse set of locations, to further explore the dynamics of supply chain resilience across different global contexts.

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APPENDICES

APPENDIX 1: INTERVIEW QUESTIONS

1. İçerisinde bulunduğunuz tedarik zinciri dizaynı ile ilgili genel bir bilgi verebilir misiniz? (Tedarikçiler, müşteriler (ülkeleri/bölgeleri))

2. Yaşanan korona virüs salgınından şirketiniz ve içerisinde bulunduğunuz tedarik zinciri nasıl etkilendi?

    - Peki korona virüs salgınının yol açtığı ne tür aksamalara sebep oldu başka aksamalar oldu mu tedarik zinciri içerisinde?

    - Şirketinizde ve içerisinde bulunduğunuz tedarik zincirinde bu aksamaları hala yaşıyor musunuz? Operasyonlarınızda eski haline dönebildiniz mi?

    - Şirketinizin finansal ve operasyonel performansı nasıl etkilendi?

3. Şirketiniz, ya da içerisinde bulunduğunuz tedarik zinciri, bu tür bir aksamaya hazırlıklı mıydı sizce? Şirketinizin ve içerisinde bulunduğunuz tedarik zincirinin hangi yetkinlikleri/hangi kaynakları sizin ayakta kalmanızı sağladı?

    - Dönemsel bir değişiklik var mı mesela ilk karantina, sonrasında normalleşme, nasıl değişiklikler oldu

4. Şirketiniz ve tedarik zinciriniz korona virüs dışında yaşanan mesela iklim değişikliğine bağlı büyük çaplı ve ekstrem diyebileceğimiz bu tip başka bir tedarik zinciri aksaması yaşadı mı?

    Evet ise,

    - Tedarik zincirinizde yaşanan bu aksamanın sebebi ve kaynağı neydi?

    - Korona virüs pandemisi ile farklar nelerdi sizce?

5. Korona virüs ve korona virüs dışında yaşanan büyük çaplı ekstrem diyebileceğimiz aksamalarda, tedarik zinciri partnerlerinizle ortak çalıştığınız noktalar oldu mu daha iyi aksiyon alabilmek için? Örnekler verebilir misiniz?

    - Tedarik zinciriniz içerisinde işbirlikleri şirketiniz için ne kadar önem taşıyor? Tedarik zinciri ağınızda işbirliği içerisinde olduğunuz iş ortaklarınız var mı? Örnek verebilir misiniz? Bu aksamaları atlatmak için neler yaptınız?

    - Bu süreçte tedarik zinciri ağınızda, tedarikçilerinizden müşterilerinize kadar iletişim ve bilgi paylaşımınız nasıldı? Görünürlük ve şeffaflık gibi kabiliyetleri düşündüğümüzde, şirketinizin performansını nasıl değerlendiriyorsunuz? Sizce tedarik zinciri ağınızda şeffaflık ve takip

edilebilirlik var mıydı bu süreçte? Bunu geliştirmek için neler yaptınız?

- Peki bu süreçte içerisinde bulunduğunuz tedarik zincirinin esnekliğini değerlendirebilir misiniz?

- Bu süreçte kapasiteleri nasıl yönettiniz?

- Bunların yanı sıra, müşteriler ve tedarikçilerle bütünleşme de tedarik zinciri verimliliğini ve müşteri deneyimini olumlu yönde arttıran kabiliyetlerden bildiğiniz üzere. Şirketinizin tedarik zinciri bütünleşmesine verebileceğiniz örnekler var mı?

- Bildiğiniz üzere dijital dönüşüm çağındayız ve yeni teknolojiler her sektör için bir gereklilik haline geldi. Özellikle moda sektöründe Yapay Zeka, Makine Öğrenimi gibi teknolojilerin tedarik zincirlerinde kullanılması hakkında ne düşünüyorsunuz? Şirketinizin ve içerisinde bulunduğunuzun tedarik zincirinin bu tarz uyguladığı bir teknoloji var mı? Varsa, tedarik zincirinizde yaşanan bu tür aksamalar için kullandığınız teknolojiler neler?

6. Bu tür aksamalara karşı dirençli tedarik zinciri geliştirebilmek adına neler yapılmalı?

7. Şirketinizin veya içerisinde bulunduğunuz tedarik zincirinin bunun için (dirençli olabilmek için) geliştirdiği stratejiler var mı? Varsa örneklendirebilir misiniz?

   - Yoksa, sizce moda tedarik zincirinde yaşanan bu tarz aksamaların etkilerini minimize edebilmek için nasıl önlemler alınabilir?

   - Bu stratejileri oluşturmaktaki motivasyonlar ve engeller neler sizce?

APPENDIX 2: DETAILS OF THE SECONDARY DATA

News	Sources (accessed between 2020-2023)
Bottlenecks at the ports: Labour disputes and congestion threaten US fashion supply chain	Vogue Business
Garment supply chain and its labour risks	Cosmos Magazine
Fashion's Supply Chain Visibility Comes Into Focus	Sustainable Brands
The end of fast fashion and emergence of a circular economy	Sustainability Mag
Major Fashion Brands Increase Emissions in 2022	STAND.earth
How the Fashion Industry Can Pave the Way for a Sustainable Future	Supply & Demand Change Executive
When apparel supply chains fail to supply	Just Style
Fast-fashion brands claim they're cleaning up their act for the planet, but their premise might be inherently flawed	Fortune
Is digitising the fashion supply chain a flawed concept	Just Style
How the apparel industry can ADAPT to inflation	McKinsey
Fashion industry challenges and global disruptions	McKinsey
Traceability Can Enable Circularity In The Fashion Industry	Forbes
Will fashion obey letter of law on supply sustainability	Supply Chain Digital
The Death of Fast Fashion, and Not a Moment Too Soon	Supply Chain Brain
Apparel brands collaborate with supply chains to drive circularity	Just Style
An energy crisis in the fashion supply chain	Drapers
With supply chain slowdowns, how can brands navigate viral trends?	Vogue Business
Steadying the ship Apparel supply chain pressure points and how	Just Style

Tackling the Growing Problem of Fashion Returns Earlier in the Supply Chain	Retail Touch Points
Making fashion supply chains more ESG compliant	Sustainability Mag
Reimagining the Fashion Supply Chain	Total Retail
Fashion Stocks Seek Redemption After Wall Street Fallout	WWD
Climate change is coming for fashion's supply chains	Vogue Business
Reshaping the fashion supply chain during a cost of living cris	Just Style
German Starts Law on Ethical Supply Chain, Plans Penalties for Violation	Bloomberg
How to tackle the apparel supply chain's biggest problems	Just Style
Apparel suppliers must adapt, collaborate across supply chain to survive	Just Style
Apparel sector loses US$15.3bn in supply chain waste report	Just Style
Experts reveal the secrets to a sustainable, resilient fashion	Just Style
Analysis: How are retailers mitigating the downfall of the pound	Retail Week
EU Moves to Regulate Apparel and Textiles Industry	WWD
Lessons to be Learned in Fashion and Apparel from 2022	Clark Hill
Fashion factory: Mango brings production closer to home in rethink on China	Financial Times
Tackling the Negative Impacts of Fast Fashion	Fibre2Fashion
China Covid outbreak threatens apparel supply chain	Just Style
China rolls out five year plan to upgrade logistics sector	Just Style
Factors that will Impact the Textile Value Chain in 2023	Fibre2Fashion

Mango publishes tier 3 factory list advancing on its sustainability vision	Just Style
Coronavirus Restrictions 'bringing shops to the brink'	BBC News
Missguided fast fashion brand collapses	BBC News
Suez blockage is holding up $9.6bn of goods a day	BBC News
Energy costs push four in 10 firms to scale back	BBC News
Shein China fashion giant investigates 'false' anti-Uyghur job	BBC News
'Price rises likely' due to UK shipping problems	BBC News
Primark says stock woes could persist until 2023	BBC News
Scottish shop sales return to pre-pandemic levels	BBC News
Primark says leggings still popular as comfort rules	BBC News
China lockdowns The economic cost of a zero-Covid policy	BBC News
How delivery drivers became vital in the pandemic	BBC News
Warning shipping delay problems to continue this year	BBC News
Clothing makers in Asia give stark coronavirus warning	BBC News
Will fashion be better for the planet after coronavirus	BBC News
Asos sees big loss as shoppers cut back on fashion	BBC News
UK tightens rules on using Uighur-picked cotton	BBC News
M&S signs call to action over Uighur forced labour	BBC News
Xinjiang cotton How do I know if it's in my jeans	BBC News
'Clothes are torn, worn out I can't find work gloves'	BBC News
Only 21 Percent of Fashion Firms Name Suppliers, Per New Report	WWD
Vietnam apparel exports seen rising 7.4% this	Reuters

year to $43.5 billion	
Factbox-How COVID-19 in Southeast Asia is threatening global supply chains	Reuters
COVID-19 Measures In Vietnam Pummel An Already Bruised Supply Chain	Benzinga
Year in Review 'Uncontrollable,' 'Tsunami' — the Supply Chain in 2021	WWD
Prosperity will be 'made in America' as supply chains buckle	Fortune
Hugo Boss Strong Resiliency In A Challenging Environment	Seeking Alpha
California Creative Economy Shows Resilience, but Fashion Sector Declines, Research Finds	WWD
What If Fashion Forecasted Climate Disasters Instead of Trends	WWD
Adaptive Fashion Apparel Retailers Must Embrace Change in 2021	WWD
Research Shows Ethical Trading Practices Bode Greater Resiliency to Pandemic	WWD
China's Sudden Shift on Zero-Covid Puts Supply Chains at Risk Again	Barron's
In Fashion Supply Chain Shutdown, Start Up and Reinvention	WWD
Why Fashion Supply Chain Traceability Is A Tech Challenge That Begins With AI	Forbes
Turkish clothing and textile sector looks towards a diversified client base beyond COVID-19	WWD
Research: In a Post-COVID 2021, Fashion Will Trend Toward Sustainability	Sustainable Brands
The great reset: Covid may have changed how and where your clothes are made	Economic Times
COVID Bangladesh′s textile industry hit hard by pandemic	DW
US brands seeing benefits of local production	Agentex
Turkey garment factories exempt from latest lockdown	Just Style

Why Turkey's Vertical Supply Chain is Fit for a Post-Covid World	Sourcing Journal
Why Turkey's Vertical Supply Chain is Fit for a Post-Covid World	Sourcing Journal
Suez Canal crisis will lead to lingering logistics disruption	Just Style
Tracking items of clothing can make fashion more sustainable	World Economic Forum
Textile and garment supply chains in times of COVID-19	UNCTAD
Garment Workers at Risk Without Access to COVID-19 Vaccine	WWD
Fashion Brands At Risk of 'Losing' Asian Labor Force to COVID-19	Sourcing Journal
Major brands owe billions to apparel factories, whose workers bear the brunt	Vox
Years after the Rana Plaza tragedy, Bangladesh's garment worker	The Conversation
Building Resiliency in Textile Supply Chain	Fibre2Fashion
How Turkish apparel manufacturers adapt to more sustainable supply chain model	Fashion United
Supply Chain Management Disruptive Element	Fibre2Fashion
H&M says sales up 75% as more people get vaccinated against Covid	Business Standard
Sourcing's new order – Covid's impact on world's top three apparel exporters	Just Style
Sourcing's new order – Covid's impact on world's top three apparel exporters	Just Style
India's Covid crisis has ripple effects for garment industry worldwide	NBC News
Fashion fails to factor in supply chain carbon	Financial Times
Second-hand clothing sales are accelerating - and bringing fashion closer to a circular economy	Business Green
COVID-19 How has the pandemic affected formal fashion	World Economic Forum
Fashion's Time for Change Adapting to Lessons	Fashion United

Learned from COVID	
What COVID-19 has done to the fashion supply chain	Fibre2Fashion
COVID-19's long wave hits Italian luxury manufacturing	Vogue Business
Italian Textile Firms Join Forces to Weather COVID-19 Fallout	WWD
Fashion retailers are changing how they deal with unsold clothes	Fortune
Your clothes are about to get more expensive	Fast Company
'Bad apples have been exposed': can a fairer fashion industry emerge from crisis?	The Guardian
Coronavirus Why the fashion industry faces an 'existential crisis	BBC News
Fast Fashion on a Fast Decline via Climate Change	BBC News
How Global Warming Is Already Changing The Fashion Industry	Fast Company
Climate sustainability in retail: Who will pay?	McKinsey
Fashion should stop blaming the weather for poor sales	Vogue Business
Fashion should stop blaming the weather for poor sales	Vogue Business
Is Climate Change Killing the Seasonality of Apparel Retailing?	WWD
Fashion on Climate	Global Fashion Agenda
Extreme weather events put $84 billion of Indian bank debt at risk	Bloomberg
The Impact of Weather on Retail Sector in the UK	WeatherAds
Fast fashion: How clothes are linked to climate change	BBC News
How climate change affects the luxury fashion industry	Fashion United
Textile Industry and Climate Change	OEcotextiles
Climate change is threatening the garment	Greenbiz

industry	
Turkey earthquake; Shaking more than just cores of the textile & apparel sector	Textalks
Textile manufacturing resumes in earthquake-affected areas of Turkiye	Fibre2Fashion
Turkiye earthquake to impact domestic textile & apparel industry	Fibre2Fashion
Quake Fallout Hits Retailers That Sought Supply Resilience in Turkey	Bloomberg
Turkish Fashion Manufacturers in Earthquake-Affected Areas Resume Production	Business of Fashion

APPENDIX 3: DICTIONARY

Supply Chain Capabilities			Keywords
Agility			çeviklik, çevik, hızlı adaptasyon, hızlı aksiyon alma, üretimi -e doğru çevirmek, -e kaymak, hızlı, entegre etmek, hız, çabuk ayak uydurmak, anlık cevap verme
Health & Safety Management			kurullar kurmak, prosedür yayınlamak, insan sağlığı, korunmak, kurul,
Financial Capability			fiyat indirimi, nakit akışı, iskonto, ödemelerini yapmak
Flexibility	**Product Development Flexibility**		"-e yönelmek, alanında çalışabilir hale gelmek, activewear, homewear
	Sourcing Flexibility	**Multi-Sourcing**	risk dağıtmak, başka ülkelere kaydırmak, lokasyonları bölmek, kaynakları dağıtmak
		Supply Base Diversification	alternatif, farklı ülkeler, tedarik yolları eklemek, başka ülkeler, farklı ülkelerden tedarik
	Manufaturing Flexibility		üretim kapasitesini arttırmak, üretimi esnek hale getirmek, tampon
	Logistics Flexibility	**Fleet Flexibility**	filo arttırmak
		Mode Flexibility	yeni yollar, tren yolu taşımacılığının artması, tren-havayolu
		Node Flexibility	depo açma
	Capacity Flexibility		kapasite, stokların fazla olması, hammadde stoğu, yedekli gitmek, önden alım yapmak, arzı kontrol etmeye çalışmak, ürünleri önden almak, stoklu gitmek, stok tutmak, stok bulundurmak, önden tedarik etmek, stok kontrol, eleman almak, kapasite artması, yedekli gitmek, çalışan sayısı artması, stokları eritmek, capacity
Supply Chain Reconfiguration			tedarik zincirinde çeşitliliğe gitmek, tedarik zincirinin yayılması, tedarik zincirini genişlet, riski dağıt, direct sourcing, tedarik zincirimi kısaltmak, outsource etmek, işletme kurdu, tesis kurmak, shorten the supply chain, reduce the number of processes, simplify the supply chain, çeşitlendir
Collaboration	**New partnerships**		partnerlikleri arttırmak, yeni partnerlikler, iş birliklerimiz
	Joint- problem solving		ilişki geliştirmek, sorunları içerde çözmek, birlikte hareket etmek, tedarik zinciri paydaşlarıyla

		yürüttüğümüz
	Co-value creation	birlikte çalışmak, bir arada hareket etmek, cost cutting çalışmaları, beraber çalışmak,
	Financial collaborations	finansal birliktelikler, firmaların birbirini desteklemesi, güven ortamının sağlanması, ödeme vadelerinin uzatılması, supplierları korumak, zamanında ödeme yapmak
Supply Chain Visibility		end-to-end solution, visibility, transparency, gerçek zamanlı bilgilendirme, şeffaf, baştan sona izlenebilirlik, hesap verilebilir, izlenebilir, şeffaflık,
Digital Transformation Capabilities	**E-commerce capabilities**	e-ticaret,
	Process Automation	otomasyon, robotic process automation, otomasyon, support of technology, intelligence in the tool
	Data Analytics	datadan çıkarım yapmak, dataya yatırım yapmak, data akması, veri almak, veriyi değerlendirmek, anlık kontrol etmek, anlık olarak her şeye ulaşmak, anlık görmek, anlık olarak takip etmek
	Digital Visualization and Archiving	dijital ortamda ürün sunumu, dijitalize olmak, dijitalizasyon, dijital ortamda sergilemek, dijital kumaş kütüphaneleri, dijital arşiv
	AR, VR and 3D Modeling	3 boyutlu tasarım,
	Artificial Intelligence (AI)	yapay zeka, algoritma
	Blockchain Technology	-
Risk Orientation		risk komitesi, kapital risk metodu, google risk report, kriz yönetimi senaryoları, pandemi komitesi, risk yönetimi
Sustainability		güneş enerjisi, gots, recycled, geri dönüştürülmüş, zorunlu kılmak

APPENDIX 4: OPL CODE FOR CLUSTERING MODEL

```
// Sets and indices
range M = 1..NbCompanies;
range N = 1..NbClusters;
range Q = 1..NbCapabilities;
// Parameters
float distance[M][M] = ...;
float capability[M][Q] = ...;
// Decision variables
dvar boolean x[M][N];
dvar boolean y[M][M][N];
dvar float+ maxDistance;

minimize maxDistance;

subject to {
  forall(i in M, j in M, k in N: i != j)
  maxDistance >=  distance[i,j]*x[i,k] + distance[i,j]*x[j,k] - distance[i,j];
  forall(i in M) {
    sum(k in N) x[i][k] == 1;
  }
  forall(i in M, j in M, k in N: i != j) {
    y[i][j][k] <= x[i][k];
    y[i][j][k] <= x[j][k];
    y[i][j][k] >= x[i][k] + x[j][k] - 1;
  }
}

execute {
  var capabilitySummary = new Array();
  for (var k = 1; k <= N.size; ++k) {
    capabilitySummary[k] = new Array();
    for (var q = 1; q <= Q.size; ++q) {
      capabilitySummary[k][q] = 0;
    }
  }

  for (var i = 1; i <= M.size; ++i) {
    for (var k = 1; k <= N.size; ++k) {
      if (x[i][k] == 1) {
```

```
      for (var q = 1; q <= Q.size; ++q) {
        capabilitySummary[k][q] += capability[i][q];
      }
    }
  }
}
writeln("Cluster Capabilities:");
for (var k = 1; k <= N.size; ++k) {
  writeln("Cluster ", k, ":");
  for (var q = 1; q <= Q.size; ++q) {
    write(capabilitySummary[k][q], " ");
  }
  writeln();
}
}
```

APPENDIX 5: C# CODE FOR THE ELBOW METHOD

```csharp
using System;
using System.Collections.Generic;
using System.Linq;

public class KMeans
{
    private double[,] distanceMatrix;
    private int numberOfClusters;
    private List<int>[] clusters;
    private List<int> centroids;

    public KMeans(double[,] distanceMatrix, int numberOfClusters)
    {
        this.distanceMatrix = distanceMatrix;
        this.numberOfClusters = numberOfClusters;
        clusters = new List<int>[numberOfClusters];
        centroids = new List<int>();
        InitializeCentroids();
    }

    private void InitializeCentroids()
    {
        Random random = new Random();
        centroids.Add(random.Next(distanceMatrix.GetLength(0)));

        for (int i = 1; i < numberOfClusters; i++)
        {
            double[] distances = new double[distanceMatrix.GetLength(0)];
            double totalDistance = 0;

            for (int j = 0; j < distanceMatrix.GetLength(0); j++)
            {
                if (!centroids.Contains(j))
                {
                    double minDistance = double.MaxValue;
                    foreach (var centroid in centroids)
```

```
                {
                    double distance = distanceMatrix[j, centroid];
                    minDistance = Math.Min(minDistance, distance);
                }
                distances[j] = minDistance * minDistance;
                totalDistance += distances[j];
            }
        }

        double randomPoint = random.NextDouble() * totalDistance;
        double cumulative = 0;
        for (int j = 0; j < distances.Length; j++)
        {
            if (!centroids.Contains(j))
            {
                cumulative += distances[j];
                if (randomPoint <= cumulative)
                {
                    centroids.Add(j);
                    break;
                }
            }
        }
    }
}

public void Run(int maxIterations)
{
    for (int iteration = 0; iteration < maxIterations; iteration++)
    {
        AssignClusters();

        RecalculateCentroids();
    }
}

private void AssignClusters()
{
```

```csharp
        for (int i = 0; i < numberOfClusters; i++)
        {
            clusters[i] = new List<int>();
        }

        int numRows = distanceMatrix.GetLength(0);

        for (int i = 0; i < numRows; i++)
        {
            double minDistance = double.MaxValue;
            int closestCentroid = -1;

            for (int j = 0; j < numberOfClusters; j++)
            {
                if (centroids[j] < 0 || centroids[j] >= numRows)
                {
                    Console.WriteLine($"Invalid centroid index at {j}: {centroids[j]}");
                    continue;
                }

                double distance = distanceMatrix[i, centroids[j]];
                if (distance < minDistance)
                {
                    minDistance = distance;
                    closestCentroid = j;
                }
            }

            if (closestCentroid == -1)
            {
                Console.WriteLine($"No closest centroid found for point {i}.");
            }
            else
            {
                clusters[closestCentroid].Add(i);
            }
        }
    }
```

```csharp
    private void RecalculateCentroids()
    {
        for (int i = 0; i < numberOfClusters; i++)
        {
            double minSumDistance = double.MaxValue;
            int newCentroid = centroids[i];

            foreach (var point in clusters[i])
            {
                double sumDistance = clusters[i].Sum(p => distanceMatrix[p, point]);
                if (sumDistance < minSumDistance)
                {
                    minSumDistance = sumDistance;
                    newCentroid = point;
                }
            }

            centroids[i] = newCentroid;
        }
    }

    public double CalculateWCSS()
    {
        double wcss = 0.0;
        for (int i = 0; i < numberOfClusters; i++)
        {
            foreach (var point in clusters[i])
            {
                double distance = distanceMatrix[point, centroids[i]];
                wcss += distance * distance;
            }
        }
        return wcss;
    }
}

public class ElbowMethod
```

```csharp
{
    private double[,] distanceMatrix;
    private int maxK;
    private int numberOfInitializations;

    public ElbowMethod(double[,] distanceMatrix, int maxK, int numberOfInitializations)
    {
        this.distanceMatrix = distanceMatrix;
        this.maxK = maxK;
        this.numberOfInitializations = numberOfInitializations;
    }

    public Dictionary<int, double> CalculateWCSS()
    {
        Dictionary<int, double> wcssValues = new Dictionary<int, double>();

        for (int k = 1; k <= maxK; k++)
        {
            double minWCSS = double.MaxValue;

            for (int init = 0; init < numberOfInitializations; init++)
            {
                KMeans kmeans = new KMeans(distanceMatrix, k);
                kmeans.Run(300); //100, 200, 300 iterations
                double wcss = kmeans.CalculateWCSS();

                if (wcss < minWCSS)
                {
                    minWCSS = wcss;
                }
            }

            wcssValues[k] = minWCSS;
        }

        return wcssValues;
    }
}
```

```csharp
internal class Program
{

    public static void Main(string[] args)
    {
        double[,] liste = { //distance matrix here


        };



        ElbowMethod elbowMethod = new ElbowMethod(liste, 10, 10);
        var wcssResults = elbowMethod.CalculateWCSS();

        foreach (var kvp in wcssResults)
        {
            Console.WriteLine($"k={kvp.Key}, WCSS={kvp.Value}");
        }
    }
}
```

ETHICAL BOARD APPROVAL

SAYI : B.30.2.İEÜ.0.05.05-**020**-*134*   18.06.2021

KONU : Etik Kurul Kararı hk.

Sayın Doç.Dr. Bengü Sevil Oflaç ve Cemre Şerbetçioğlu,

"Moda Sektöründe Dirençli Tedarik Zincirlerinin Stratejik ve Operasyonel Bakış Açılarının İncelenmesi" başlıklı projenizin etik uygunluğu konusundaki başvurunuz sonuçlanmıştır.

Etik Kurulumuz 18.06.2021 tarihinde sizin başvurunuzun da içinde bulunduğu bir gündemle toplanmış ve ve Etik Kurul üyeleri projeleri incelemiştir.

Sonuçta 18.06.2021 tarihinde **"Moda Sektöründe Dirençli Tedarik Zincirlerinin Stratejik ve Operasyonel Bakış Açılarının İncelenmesi"** konulu projenizin etik açıdan uygun olduğuna oy birliği ile karar verilmiştir.

Gereği için bilgilerinize sunarım.

Saygılarımla,

Prof. Dr. Murat Bengisu
Etik Kurul Başkanı