



# **DOCTORAL DISSERTATION**

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Sopron

2022

# Strategic analysis of product variety and supply chain complexity in the fast fashion apparel industry

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within the framework of the

Joint Cross-Border PhD Programme

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yes / no

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Date of the comprehensive exam: 20\_\_\_\_ year \_\_\_\_\_ month \_\_\_\_\_ day

Result of the comprehensive exam \_\_\_\_\_ %

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Result of the public dissertation defence: \_\_\_\_\_ %

Sopron, 20\_\_\_\_ year \_\_\_\_\_ month \_\_\_\_\_ day

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Qualification of the PhD degree: \_\_\_\_\_

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## ABSTRACT

Firms today need to deal with higher complexities in their operations. Such complexities may derive from an increase in product variety. On one hand, firms have to adapt to their customers' heterogeneous demands by creating more product varieties so they can remain competitive. On the other hand, they must deal with the consequences resulting from such an increase in their product variety.

Firms need to consider all related areas, such as supply chain integration when initiating any change to their product variety. In this regard, the division of labor principle may enable them to concentrate on their supply chain system's core competencies while building their product variety.

This thesis examines the relationship between product variety and supply chain performance. The urgency of this research becomes apparent due to the conflicting findings from the research community, including the conflicting views on the correlation between product diversity and supply chain performance.

From the total of 485 supply chain managers and decision-makers who participated in this study's survey by completing the questionnaire mostly including questions in the Likert-scale, most of them regarded product variety as the main driver of their supply chain complexities.

It was intriguing to learn that a 1 to 4 % product variety increase affected slow fashion, fast fashion, and other industries' financial and qualitative performance differently. However, the difference became less apparent when the increase rose to 5–10%. The statistical evaluation showed a significant connection between the performance measure used and the success of supply chain management. Another fundamental finding confirms a connection between supply chain members' type of relationship and the system's sustainability. Thus, mutually trusting relationships between firms and their suppliers are crucial for maintaining sustainable practices in the long term.

## KEYWORDS

Supply Chain

Product variety

Product diversity

Fast fashion supply chain

Supply Chain Performance

Product variety increase

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## LIST OF ABBREVIATIONS

SCM	Supply Chain Management
SKUs	Stock keeping units
IT	Information Technology
MOP	Manufacturing Operational Performance
GSCM	Green Supply Chain Management
PV	Product Variety
FMCG	Fast Moving Consumer Good

## 1. INTRODUCTION

Firms that intend to offer a greater variety of products today may face serious performance losses in the supply chain tomorrow if they are not aware of the drivers and consequences of product variety.

There seems to be no limit to product varieties whether in stationary supermarkets or online shops. On the one hand, the population keeps growing, leading to people's more heterogeneous needs. On the other hand, companies aim to meet these needs to increase customer satisfaction. Some customers might find deciding on which yogurt they want on the supermarket shelf to be exciting. For some others, the variety of different yogurts on the supermarket shelf, e.g. yogurt with 3.5% fat, skimmed milk yogurt, greek yogurt, cream yogurt, yogurt with fruit preparation, yogurt with fruit flavor, yogurt with fruit, etc. might be confusing and complicating their purchase decision. Consequently, they might end up purchasing no yogurt at all.

From a firm or supply chain perspective, there is just as much a dilemma regarding product variety. Should they accommodate various customer needs without restriction, or should managing directors and supply chain managers buck the emerging trend of ever-increasing product variety? Anyone with common sense would think that firms should not decide in favor of one extreme or the other. Rather, they should treat product variety in a more differentiated way (e.g. by considering also the drivers and consequences of product variety).

This study presents both positive and negative effects of product variety. The increase in sales, market share, and satisfied customers represent strong incentives for offering a high product variety. Besides, it is a promising defensive strategy to protect products against competitors and therefore is an important means for sharpening the firm's competitiveness. But it is just as important to learn about the downsides of high product variety, such as more complex demand forecasting, longer lead times, and the increase in complexity in design, manufacturing, and scheduling. The cost leadership strategy suggests that a smaller variety of products would be preferable as it allows firms to benefit from the economies of scale application in their supply chain. This brief insight into some of the upsides and downsides of product variety may give a rudimentary idea of this study's focus.

It seems that nowadays, firms seek to establish a stable network chain with other firms to remain competitive. While many studies have covered product variety and supply chain management topics, there is still a huge gap in the study area. Since supply chains and product variety are a source of competitive advantages, firms must focus on product diversity and the associated supply chain performance to ensure that the two elements develop harmoniously.

This dissertation consists of four main chapters. The literature review chapter presents existing relevant literature that serves as the foundation for this study's hypotheses. The methodology chapter presents important details of the survey questionnaire and data collection and analysis approaches employed by this study. The main findings chapter lists the results of the survey, most notably those related to product variety and supply chain performance. Furthermore, this part also presents the association between those results and this research's hypotheses as well as other external scientific findings. It also presents the current study's limitations and some future research directions. A summary is provided in chapter 5.

## 1.1 Research needs and objectives

Given the fact that product variety is one of the static drivers of complexity in a supply chain (Serdarasan, 2013), it offers both positive and negative impacts on supply chain performance. The growing number of products in the supply chain may complicate its management due to the involvement of more activities and processes (Hu et al., 2008; Wong et al., 2015; Fisher et al., 1999; Thonemann et al., 2002; Um et al., 2017).

This thesis investigates the trade-off between high product variety levels and the supply chain's qualitative and quantitative performance. In some sectors, most notably those with short product life cycles such as the apparel industry, the demand for product variety is considerably higher than in other sectors. Therefore, one focus is also on the fast fashion industry which depends on rapid responses.

The research's objective is to determine the relationship between product variety and the supply chain. One of the central hypotheses states that performance-wise, supply chain systems' complexity does not affect firms' performance. Another hypothesis argues that product variety level does not affect the supply chain performance of both slow fashion

and fast fashion firms. Statistical examination of data gained from 485 supply chains in different industries worldwide serves as the basis for testing these hypotheses.

The research's most important objectives are:

- To get an overview of respondent's supply chain systems (e.g. reasons why respondents operate in supply chains, how much they agree that their supply chain is complex, their most important reasons for high supply chain complexity, their assessment of own supply chain management).
- To understand the role of product variety as a complexity driver.
- To understand how complex the supply chains in which operations are performed are.
- To determine the extent of the supply chain complexity associated with product variety.
- To understand the effects of product variety increase at different levels on qualitative as well as the financial performance of the supply chain in the short- and medium-time frame for slow fashion, fast fashion, and other industries.
- To determine the extent of different assessment of supply chain performance of fast fashion and slow fashion firms.
- To better understand the role of relationships between supply chain partners (e.g. ongoing partnerships) and their impact on supply chain performance.
- To understand the role of relationships between supply chain partners and the implementation of sustainable supply chain practices, considering performance-relevant indicators.

## 1.2 Research questions

This research aims to help supply chain stakeholders, including business leaders and decision-makers, supply chain managers, and leaders from different industries around the world, deal with one of the many challenges in their supply chains by uncovering the product diversity–supply chain performance relationship. In addition, this research also identifies the impacts of product variety on supply chain performance. There has yet been any study in this context covering that particular topic. While many studies only focus on a specific country, this study explores the prevalence of the product diversity–supply chain performance relationship in multiple countries and diverse sectors of industry (including fast and slow fashion) simultaneously.

The following are the study's research questions:

- How do the key characteristics of respondent's supply chain systems look like in terms of supply chain complexity, firm's interaction with supply chain partners, and certain performance-relevant indicators?
- Are there differences between more and less complex supply chains with respect to the impact of an increase in product variety on certain performance-related indicators?
- Are there differences between different types of industries (slow fashion, fast fashion, and other industries) with respect to the effect of a product variety increase at different levels on financial (qualitative) performance in the short and medium run?

The terms "product variety" and "product diversity" are used synonymously throughout this research.

## 2. LITERATURE REVIEW

This chapter examines the current state of research on the influence of product variety on supply chain performance topic. It investigates the role of product variety as a complexity driver in the supply chain in more detail. The chapter also focuses on assessing performance indicators in the research while determining if there are positive or neutral effects of product variety increase on a firm's supply chain performance. In specific, the discussion revolves around the impact of the product variety–supply chain performance relationship on the fast-fashion industry, especially on how the relationship affects the response time of fast-fashion firms. The chapter also attempts to investigate how business practice and management theory adopt the concepts of product variety, supply chain management, and sustainability.

### ***2.1 Enlightening insights of literature***

One question always emerges in every discussion regarding product variety and supply chain management; to what extent are competitive advantages achievable through the maintenance of the product variety–supply chain relationship? That said, it is fundamental to apply Porter's generic competitive strategies to this study as they offer a comprehensive connection for the topics that it covers.

#### ***2.1.1 Product variety***

Globalization and market competition force managers all over the world to focus on their competitive strategies. Decisions on product variety are challenging due to the high expenses, investments, and risks of dealing with strategic considerations. To determine which specific strategy to pursue, managers can apply Porter's generical competitive strategies comprising the cost leadership strategy, differentiation strategy, and focus strategy with the two variants: cost-focus and differentiation-focus.

While the cost leadership strategy enables firms to become low-cost producers, the differentiation strategy helps them establish uniqueness (e.g., regarding the product). Meanwhile, the focus strategy helps firms draw attention to specific target segments. In this context, generic strategies are considered competitive advantage tools (Porter 1985).

Table 1 provides an overview of the three generic strategies and discusses the potential pros and cons associated with each strategy (Chege, 2017).

Table 1: Porter's generic competitive strategies

	<b>Cost leadership strategy</b>	<b>Differentiation strategy</b>	<b>Focus strategy</b>
<b>Objective</b>	Aiming to become a low-cost producer.	Aiming to offer a product or service on the market that is unique.	Aiming to offer attractive products for a specific niche market.
<b>Advantages</b>	<ul style="list-style-type: none"> <li>• If successfully implemented, the strategy may help to reduce the threat from new entrants.</li> <li>• Especially in case of standardized products, consumers will prefer products at lower prices, which are possible due to the low production costs.</li> </ul>	<ul style="list-style-type: none"> <li>• Offering differentiated products often builds customer loyalty.</li> <li>• Meeting various customer needs.</li> <li>• May provide protection against competitive rivalry (customers may be less sensitive to price changes due to customer loyalty).</li> </ul>	<ul style="list-style-type: none"> <li>• Contains good growth potential.</li> <li>• The customer loyalty associated with this strategy may discourage potential competitors.</li> <li>• Since there are no close substitutes, companies can sell products at higher prices.</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>• The cost leadership strategy depends on access to financial sources.</li> <li>• In the environment of a transformation economy, this strategy loses its relevance.</li> </ul>	<ul style="list-style-type: none"> <li>• The differentiation strategy is challenging to implement (this can only be done with special attention to organizational structure and management).</li> <li>• Requires a high level of creativity and product re-engineering skills.</li> </ul>	<ul style="list-style-type: none"> <li>• Over time, customers' needs will change, which could allow competitors to catch up because they are better able to meet the needs.</li> </ul>

Source: Author's table

The next step is to determine the connection between the three generic strategies described above and this dissertation's core topics, including product variety and supply chains. The following list describes the context of such a connection (Ciesielski et al., 2013):

- Decisions on product variety and product diversification align with differentiation since they focus on creating a convincing unique product or product portfolio.
- As a general rule, supply chain strategies are competitive strategies.

- Global supply chains are affected by global price pressure which forces them to lower their price and adopt a low-cost strategy.
- As stated by Christopher et al. (2001), supply chain systems compete with each other nowadays. Therefore, supply chain systems also need to adopt competitive strategies.
- The product differentiation strategy can be measured by, among other things, the provision of unique product features or the introduction of new products (Chenhall & Langfield-Smith, 1998), which leads to product variety or product diversification.

Product diversification is a business development strategy that enables firms to access new business opportunities (Van Kranenburg et al., 2004; Syokau et al., 2021). These opportunities may include the development of unique products, services, and markets. It must be considered whether the additional products are strategically linked to the existing business lines (concentric diversification) or not (unrelated diversification). A major objective for diversifying is to improve organizational performance. The term "product variety", in this regard, means the "number of different versions of a product offered by a firm at a single point in time (Randall & Ulrich, 2001) or "the number of variants within a specific product group" (Lancaster, 1990).

Having an extensive list of product varieties is a growing trend in many industries nowadays (Cachon et al., 2005; Scavarda et al., 2008). ElMaraghy et al. (2013) and Thonemann et al. (2002) also described the significance of product diversity increase. Aichner et al. (2013) even thought that the increasing level of product variety is one of the essential features of modern economic systems.

The product variety trend in 2012 within the US market had increased fivefold compared to 1970. Meanwhile, the newspaper increased fifteenfold and TV screens increased ninefold within the same timeframe. In 2012, there was five times more product variety in movies (at the cinema), 31 times more in breakfast cereals, and 13 times more in types of milk compared to 1970. The number of product varieties increased eightfold for mouthwash, 674-fold for sports shoes, twelvefold for brands of mineral water, and 119-fold for types of tights (Aichner et al., 2013).



Bils and Klenow (2001) indicated that product variety increase had been about 1% per year over the past 40 years. Interestingly, the study estimates that most of the growth has occurred in the last 20 years. Studies do not only focus on product diversity increase in consumer and intermediate goods (Bils et al., 2001) but also across many sectors like apparel, toys, power tools (Fisher et al., 1994), computers (Bayus et al. 1999), automotive (Pil et al., 2004) and chemicals (Ramdas et al., 2003). Products across all categories of consumer goods and services have been expanding at an unprecedented rate, with no sign of slowing down (Quelch et al., 1994).

Thonemann et al. (2002) summarized the findings of various reports and concluded that the variety of products in most industries has increased significantly in recent decades. The packaging industry has seen strong growth in product diversity, with the number of newly launched products doubling from 12,000 in 1986 to 24,000 in 1996. A similar development was also evident in modern supermarkets, with a drastic increase in the number of products available from around 1,000 in the 1950s to a whopping 30,000 in 2002 (Thonemann et al., 2002).

The number of selections in almost all product categories has exploded in the last few decades (Xia et al., 2009). In most industry sectors today, companies offer multiple varieties of similar product types. A prime example is the magazine industry, where media companies launch several different titles within the same segments to address different reader preferences. Another example would be automotive manufacturers which offer different car models in diverse segments. Beer breweries also cater to different tastes by offering different brands (Kaiser et al., 2019).

Globalization (Groote et al., 2011; Huddiniah et al, 2019; Perona et al., 2004) or increased competition resulting from globalization (Trattner et al., 2019) becomes the key driver of the trend of product variety increase across different sectors. Other drivers include individualization (Brosch et al., 2011; Hu et al., 2008), demanding customers (Pil et al., 2004), heterogenous customer demands (Trattner et al., 2019), innovation (Perona et al., 2004), and technological advancement (Huddiniah et al., 2019). Moreover, Fisher et al. (1994) added global competition, faster product development, and ever more flexible manufacturing systems to the list of drivers.

A firm's product variety level determines its strategic orientation, including strategic goals and movement (Um et al., 2018). Its strategic focus further influences stakeholders'

decisions on product variety (Lancaster, 1990). Firms often regard product variety as a necessary or inevitable factor to satisfy the needs of demanding consumers and that complicates their operational procedures (Fisher et al., 1995).

Determining the number of different product variants is one of the key problems that managers must solve. Existing literature mainly focuses on investments in product variety and ignores other strategic decisions of the company. For example, there is an interaction between investment in quality and product variety. Satisfaction with the quality of a product affects the profitability of a company's product selection because it would convert more customers into loyal ones (Kaiser et al., 2019).

Porter's generic strategy model may help explain product variety (Porter, 1985). Strategy literature describes differentiation as a condition where a firm has different products from its competitors. For instance, a firm may offer its products at a different price or manufacture different product varieties. The dimensions of product variety are manifold, as firms may pursue diversity by varying materials, colors, and components in the case of a bicycle manufacturer. To create a competitive advantage as postulated by Porter, a firm has to offer dimensions of variety that are of value to the customer (Ramdas, 2003, Porter 1985). In this regard, product variety serves as a means to enhance or generate greater competitiveness (Mehrojoo et al., 2014; Santos et al., 2020; Huddinah et al., 2019; Wan et al., 2017; Berry et al., 1997; Escobar-Saldívar et al., 2008; Chen et al., 2012). Firms across different industries view product variety as an important competitive strategy tool (Bayus et al., 1999) for denying competitors access to market segments (Wan et al., 2014), bringing new products to the market, or asserting themselves against global competitors (Huddinah et al., 2019). It is sometimes hard for firms to offer additional product variants due to competition (ElMaraghy et al., 2013). However, Ramdas et al. (2003) and Santos et al. (2020) argued that product variety does not guarantee sales in the long term and may even worsen competitiveness. Berry et al. (1999) added that high product variety is by no means a guarantee for competitiveness, while the right alignment of marketing and manufacturing strategies of product variety is.

Offering product variety is not merely a means of having an edge over the competition (Santos et al., 2020). Other motives for pursuing product variety include fulfilling the taste of diverse consumers (Lancaster, 1990) as well as their desires and demands (Mehrojoo et al., 2014; ElMaraghy et al., 2013; Santos et al., 2020) while targeting

new customer segments and, therefore, reaching new customers (Myrodia et al., 2014; Santos et al., 2020). Some firms also aim to strengthen competitiveness by introducing more product variants. When firms manage to achieve a competitive advantage through the variety of products on offer, their market share may increase (Huddinah et al., 2019). Moreover, they may also generate more revenue (Um et al., 2018) through higher prices or increased market share (Cachon et al., 2005) and sales improvement (Santos et al., 2020). They may also increase their income and sales volume (Huddiniah et al., 2019).

It is intriguing to see which method helps firms meet the growing consumer demand for a greater product variety more effectively; putting several standard products up for sale or offering custom products. Some product categories, such as TVs and cameras, only offer standard products. Other product categories offer only custom products (e.g., aircraft). Meanwhile, others offer a mixture of standard and custom products, including apparel and furniture. While a standard product may be readily available, it does not fully meet customers' product attribute preferences. A custom product, on the contrary, corresponds to customer preferences but is only available after a lead time. In this regard, an increase in sales can result from a product variety increase for standard products or a reduction in the lead time for custom products (Xia et al., 2009).

Finding the balance between customer satisfaction and operational complexity or between complexity and innovation is one of the requirements in product variety management (Gottfredson et al., 2005). More diverse products often come with greater complexity of product management (Cotrell et al., 2004). The literature also balances between potential gain in revenues and lower production costs as well as fewer product variants is something firms shall pursue (Lancaster, 1990). Several studies outline the trade-offs that firms need to perform to create new product variants, including compromising their production costs and revenue (Mehrjoo et al., 2014), balancing between positive and negative forces (Wan et al., 2012), or managing the trade-off between economies of scale and scope (ElMaraghy et al., 2013). Product variety increase raises a cost burden since it raises the scale in the supply chain and affects the cost leadership strategy negatively (Um et al., 2018). Furthermore, a firm's product variety allows it to synergize its products through underlying technologies and enables the realization of economies of scale in different business areas (Ramdas, 2003). Firms should also consider the costs of cannibalizing existing products (Anderson et al., 2006). They must also find agreement in other areas, e.g. a balance between improved demand and planning

complexity (Escobar-Saldivar et al., 2008) or the compromise between product variety and SC performance (Um et al., 2017).

Firms must understand the cost and revenue trade-offs caused by product variety (ElMaraghy et al., 2013). Fisher et al. (1995) argued that such a trade-off approves a high product variety level. It has both positive and negative effects; it may potentially generate a higher revenue while increasing production costs and exacerbating the 'black-and-white' way of thinking that prevails in many companies at the same time.

Many studies have outlined the downsides of high product variety levels. One of them described product variety as harmful as it comes with various complicated processes (Hu et al., 2008). Trattner et al. (2017) presented the relationship between product variety and manufacturing operational performance (MOP). MOP refers to the assessment of factors such as cost, time, quality, and flexibility within the production environment in manufacturing companies. These factors refer to the reduced productivity due to the higher variety of products as well as the related higher responsiveness because of the use of smaller batches (Trattner et al., 2017). Salvador et al. (2002) highlighted the risks of product diversity on operational performance and introduced the concept of modularity as a viable means of mitigating those risks since it reduces transaction costs (Halldorsson et al., 2007). The authors also showed that some companies prefer to offer fewer product varieties to keep their intensity of price competition low. Alptekinoglu et al. (2008) presented that a mass producer who competes with a mass customizer offers fewer product varieties than a mass producer monopolist to manage price competition. Xia et al. (2009) found that an increase in product variety will not lead to an intensification of price competition. Any association between greater product variety and higher prices depends both on the predominant competitive structure and the relative costs of different production technologies (Alptekinoglu et al., 2008). Firms may adopt any of the two adaptation approaches to product variety types, namely new product introduction and product extension, where the first is deemed a positive compared to the latter (Cottrell et al., 2004). The difference between the two types would be that product extensions result from the idea of serving different customer segments or using excess production capacity (Kadiyali et al., 1999). Meanwhile, line extensions may harm firms and their product management (Cottrell et al., 2004). They may weaken the competitive position of the core product through cannibalization (Kadiyali et al., 1999). Studies related to product variety focus on different industries. Cottrell et al. (2004) investigated product variety and economies of scope in the

Microcomputer Software Industry. They declared that modifications in product variety have both positive and negative effects on business survival. While new product introductions correlate with a decrease in exit, entering a new category increases exit probabilities (Cottrell et al., 2004). Fisher et al. (2005) created a basis for understanding product variety and flexibility in the auto industry. The automotive sector also serves as an example in the study of Fisher et al. (1999a) as it deals with component sharing for product diversity management. MacDuffie et al. (1996) concentrated on the automotive sector when examining the relationship between product variety and manufacturing performance. Furthermore, Scavarda et al. (2008) provided an overview of the current situation of product diversity in the automotive industry across different countries. They evaluated the cost effects of variant-driven complexity in more detail. Ding et al. (2007) dealt with product complexity caused by product diversity and its impact on many cost areas in the automotive sector. The automotive industry seems to be a popular field of research for product variety (Trattner, 2019; Holweg, 2004; Scavarda et al., 2005; Scavarda et al., 2007; Schleich et al., 2007; and Moreno et al., 2017).

Santos et al. (2020) focused on the consumer goods industry. They investigated the effect of product variety decisions. Meanwhile, Randall et al. (2001) examined the relationship between product diversity and firm performance in the US bicycle industry. Trattner (2019) identified the challenges of a high product variety for firms in the process industry, with the characteristic features of automated systems designed for the mass production of a narrow range of products. Moseley et al. (2016) concerned themselves with the influence of product variety on production performance, focusing on the process industry. A low-volume product may not negatively impact the company's production performance if firms give it a longer run length. On the contrary, a mass product produced in small runs and scheduled beyond the respective production sequence can harm production performance. Denton et al (2003) focused on product variety management at integrated steel mills. These mills face competitive pressures to increase the variety of products they manufacture and improve their responsiveness to market demand. Mehrjoo et al. (2014) related their study to the fast fashion apparel industry. Van Kranenburg et al. (2004) defined product diversification as a strategy that involves expansion into new market segments as they investigated its adoption in the publishing industry. They discovered that there is no difference in the product diversification strategies of firms

across different geographic areas. Meanwhile, Wan et al. (2012) investigated product variety decisions and sales performance of major soft drink bottlers.

The study conducted by Syokau et al. (2021) investigated how far the strategy of product diversification influences firms' supply chain performance. In total, 44 management employees, including top managers, line managers, and supervisors, participated in a semi-structured survey. The survey's results show a positive and significant association between product diversification and supply chain performance. For example, it was examined to what extent the respondents agreed with the statements "the firm has developed new product varieties," "the firm has considered adding more products to the market," and "the firm has experienced an increase in profits."

It is interesting to learn that there is little evidence that product diversification strategies benefit firms in terms of economies of scope in production (Cottrell et al., 2003). Although firms that diversify along the product dimension benefit from economies of scope in consumption, where consumers prefer to buy product variety from a single vendor, scope economies remain to be vital for the outcome of various product varieties. In addition, it is found that product variety, driven by new product introductions, performs better in terms of firm performance. However, extensions to existing products impede a firm's performance. It is worth noting that Cottrell et al. (2003) focused on the microcomputer software industry.

Summing up, chapter 2.1.1 delivers the following key insights:

- Porter's generic competitive strategies help to understand product variety and supply chain management.
- In the figurative sense, product variety can be understood as the **number of different product versions** offered by a firm.
- The product variety increase phenomena is prevalent across different industries – from automotive to toys up to apparel.
- Main drivers of product variety increase are **heterogenous customer demands** and **increased competition due to globalization**.

- To generate competitive advantages, the offered product varieties must **offer added values to customers**.
- Advantages of high product variety for firms include: **competitive advantage**, increase of income, and **sales volume increase**.
- Product variety increase opens trade-off opportunities for firms, such as:
  - The one between potential gain in revenues and lower production costs.
  - The one between customer satisfaction and operational complexity.
- Disadvantages of high product variety for firms include:
  - **complicated firm processes**
  - costs of cannibalizing existing products
  - cost burden increase.

The explanations in subsection 2.1.1 show that product variety is an important source of competitive advantage. In this regard, supply chains also aim to create such an advantage for individual members of a supply chain (Mentzer et al., 2001). One of its drawbacks would be that it makes modern supply chains more complex and affects their performance. In addition, product variety affects logistics operations (Mehrjoo et al., 2014). Therefore, it poses a big challenge to supply chain management (SCM), as explained in subsection 2.1.2.

### ***2.1.2 Supply Chain Management***

Supply chain structures appear as soon as the value chain expands beyond the firm's boundaries (Sweeney, 2009). The supply chain, therefore, consists of different value chains (Porter, 2000). Porter's management concept of the value chain explains that each activity in the firm's value chain can be evaluated in terms of its competitive advantage by systematically identifying the firm's core competencies and outsourcing the "non-core" activities (Sweeney, 2009).

The moment a value chain transforms into a supply chain, the flow of information and good is no longer referred to as logistics but as supply chain management. The idea of supply chain management is to control a predetermined set of activities from a vantage point (Lamming, 1996).

While logistics is a part of supply chain management, which, among other things, ensures efficient and effective forward and reverse flow and storage between the point of origin and the point of consumption, supply chain management serves an important integrating function by merging business processes and functions within and across companies into a high-performance business model. The supply chain management's activity area extends to various stakeholders (e.g. suppliers, intermediaries, third-party service providers, and customers) and incorporates supply and demand management within and across companies (Christopher, 2011; Council of Supply Chain Management Professionals, 2022).

A supply chain is a network of materials, information, and services that process supply and demand. With supply chains, the focus is no longer on a single firm or organization. The new perspective is that companies are linked in a networked supply chain (Paulraj et al., 2004). Supply chain management spans the operational (e.g., truck loading), tactical (e.g., purchasing and production decisions) as well as the strategical level (e.g., supplier selection and product design) of the firm's activities (Simchi-Levi et al., 2008).

Supply Chain Management is a young and upcoming field of practice and academic domain that is still evolving. It addresses different fields like logistics, operations management, purchasing and supply management, industrial relationship, marketing, and service management holistically. Supply chain management can be assigned to strategic management, which deals with strategic partnerships (Storey et al., 2006). Interest in supply chain management has grown steadily both in industry and academics in the last two decades (Simchi-Levi et al., 2008). This is also reflected in the exploding amount of studies about supply chain management. However, there is still a lack of a reliable conceptual framework and reliable constructs to sustainably advance the area of supply chain management (Paulraj et al., 2004).

Furthermore, the motive of competitive advantage and the related improved profitability is to enhance supply chains. Firms can enhance each member's supply chain's



competitive advantage (Mentzer et al., 2001; Cooper et al. 1993) by managing the supply chain as an entity. The success of supply chain members depends on their configuration (Monczka et al., 2009). Proper supply chain management affects organizational performance through competitive advantage. Successful supply chain practices ensure an improvement of an organization's competitive advantage through price/cost, quality, delivery dependability, time to market, and product innovation (Li et al., 2006). To enhance the competitiveness of their supply chain performance, firms need to create a strategic alignment to devise supply management goals with business unit goals (Monczka et al., 2009).

Several complex factors such as product variety enhance supply chain complexity. Firms with high product diversity and low production volume tend to have more complexities compared to those with fewer product varieties and higher production volumes (Salvador et al., 2002).

The effects of product variety on supply chain performance are both positive and negative (Wan et al., 2017). However, firms must be ready to address the out-of-stock risk that comes with high product variety levels. Therefore, they shall find a trade-off between these positive and negative effects (Mehrijoo et al., 2014). Before going into more detail about the relationship between product variety and supply chain performance, it is important to understand what supply chain performance is and what indicators of such performance the literature mentions. Supply chain performance matters more than ever when supply chains, not companies, compete against each other (Kushwaha et al., 2012). Supply chain performance has become a significant source of sustained benefits in many industries as global competition has accelerated over the past decade (Hoole et al., 2005). In this regard, supply chain performance determines who wins the competitive battle. The supply chain must deliver its best performance to achieve maximum competitive advantage. Unfortunately, many companies are stumbling cluelessly about how their supply chains perform or what supply chain system they are in (Kushwaha et al., 2012).

Firms can determine their supply chain performance both by the satisfaction of the customers and by the costs incurred in the logistical process (Estampe et al., 2013). Appropriate measures of performance (Simatupang et al., 2002) direct their focus toward maximizing value to end consumers and minimizing individual costs. Performance metrics should deal with the big picture and measure the entire supply chain performance rather

than the performance of individual members (Simatupang et al., 2002). A successful supply chain strategy utilizes metrics that balance performance with the objectives of supply chain members (Lambert et al., 2001). Surprisingly, many supply chains perform poorly, despite the use of supposedly powerful technology and brainpower aiming to improve supply chain performance. Firms may expect concepts such as Point-of-Sale Scanners, Quick Response, Efficient Consumer Response, Accuracy Response, Mass Customization, Lean Manufacturing, and Agile Manufacturing, to name a few, to increase supply chain performance (Fisher et al., 1997). The above studies describe how important supply chain performance is to the competitiveness of the supply chain. Different authors outline the necessity for product variety–supply chain performance trade-off (Thonemann & Bradley, 2002; Um et al., 2017). The conflicting views among these authors regarding the impact of a variety of products on supply chain performance depend on whether it is a “useful variety”, which makes the costs lower than the sales (Perona et al., 2004).

Understanding the role of product variety as a driver of supply chain complexity is important (SerdarAsan, 2013) because firms need to deal with such complexity (Perona et al., 2004). Increased product variety increases the overall supply chain complexity (Milgate, 2001; Huddiniah et al., 2019; Perona et al., 2004). Wan et al. (2017) pointed out that product variety raises both the complexity and uncertainty in the operating environment at the same time. Moreover, decision quality may suffer due to the increase in product variety (Wan et al., 2017). Wan et al. (2014) further presented the negative impacts of product diversity on logistics service levels. Some of these impacts include more complex processes in the areas of forecasting, handling, storage, and transportation. The increase in complexity affects supply chain performance, leading to an imbalance between supply and demand as forecast errors increase (Randall et al., 2001). In addition, the picking and loading times are longer, leading to a reduction in fulfillment rates (Wan et al., 2014). Product variety leads to inefficient supply chains, whereas simplification (e.g. in the form of fewer products) enhances overall performance (Hoole, 2005). Vachon et al. (2002) investigated the relationship between supply chain complexity and delivery performance and discovered that firms with more complex product portfolios show less reliable delivery (Vachon et al. 2002). Fisher et al. (1995) mentioned the complexity of a supply process increases along with an increase in product variety because more parts require more coordination effort.

An increase in product variety equals an increase in production and distribution costs due to economies of scale in the supply chain (Um et al., 2018; Wikner et al, 2007). Randall et al. (2001) supported such an argument. Firms associate production costs as additional investments with the offering of additional products. Higher production costs resulting from the division of volume between several products. Firms cannot enjoy a bulk discount for the purchase of a large amount. Moreover, it is more difficult to reach efficiency. Market mediation costs arising due to uncertainty in product demand stem from high product variety. Variety-related inventory holding costs, costs arising when supply exceeds demand or when demand exceeds supply, fall in the category of market mediation costs (Randall et al., 2001; Fisher et al., 1997). Market mediation costs, therefore, lead to lost sales prospects and unsatisfied customers. Market mediation also plays a role if a firm deals with functional products associated with predictable demand, where an almost perfect balance between demand and supply can be achieved. However, high product variety and, unfortunately, unpredictable demand characterize innovative products (Fisher et al., 1997).

MacDuffie et al. (1996) and Moseley et al. (2017) suggested that high product variety harms productivity. They defined productivity as the efficiency of conversion of outputs into physical inputs (MacDuffie et al., 1996). Stalk et al. (1998) described that halving product variety increases productivity by 30%, reduces costs by 17%, and reduces the break-even point. Trattner et al. (2017) showed the following relationship: the increase in product variety leads to an increase in set-up time and a reduction in line speed, leading to lower productivity and efficiency. Huddinah et al. (2019) indicated that the potential of Information Technology (IT) may increase the productivity of business processes. Collaborative relationships may increase productivity (Soosay et al. 2008). As Lancaster (1990) stated, product variety has the potential to increase the overall demand of the firm since it enables it to meet the expectations of heterogeneous customers.

Wan et al. (2017) aimed to learn more about the relationship between product variety, forecast bias, and inventory level. They proposed vertical integration as a mediator, focusing on the distribution network of the soft drink industry with established make-to-stock inventory management systems. Based on a forecast of future demand, soft drink companies produce and store finished products in distribution centers. Their study showed that a reduction in forecast bias reduced inventory levels resulting from increased product variety. This finding confirms the mediating role of forecast bias in this context.

Furthermore, vertical integration mitigates high inventory levels resulting from increased product variety. Vertical integration functions as the moderator of the product variety – forecast bias-inventory relationship. The vertical integration strategy has reduced the impact of product variety on forecast deviation and inventory levels (e.g., due to the increased transparency of information resulting from vertical integration). The study mainly examines inventory performance and ignores soft performance measures (e.g., customer satisfaction). The vertical integration strategy implementation is not a viable option for firms. Thus, the study's findings do not apply to all firms, most notably those that have not established vertical integration.

Furthermore, an increase in product variety affects the firm's fill rate, or the percentage of fulfilled orders out of the volume of the total order, negatively (Wan et al., 2012; Santos et al., 2020; Wan et al., 2012; Wan et al., 2014). Wan et al. (2012) illustrated the relationship between product variety and sales performance as an inverse U-shaped function. Product diversity is initially associated with increases in sales because a high level of product diversity addresses variety-seeking consumers. However, the increase in sales shows a diminishing rate of increasing product variety due to product cannibalization. When product variety reaches a certain level, the effect of product variety on sales is negative due to fill rate and product cannibalization. Therefore, fill rate serves as an intermediate variable as it facilitates the indirect effect of product variety on sales (Wan et al., 2012).

A higher product variety does not always lead to an increase in sales, as the practical example of Proctor and Gamble shows. When the firm reduced the number of versions of the Head and Shoulders shampoo from 26 to 15, it saw a 10% of sales increase (Schwartz, 2000; Osnos, 1997). The increase in product variety links to higher inventory (Santos et al., 2020; Randall et al., 2001), and is attributable to larger numbers of SKUs (Wan et al., 2017). It has to be pointed out that shampoo is a fast-moving consumer good.

After gathering data from 356 stores, Ton & Raman (2006, 2010) concluded that an increase in product variety and inventory level per product provokes more phantom products that are unavailable to customers as they are only available in the storage area but not in the selling area. Moreover, retailers normally face shelf space constraints. Quelch et al. (1994) demonstrated that product variety is increasing much more rapidly than the shelf space available. Specifically, the authors found that the number of products on the market

increased by 16% annually between 1985 and 1992. However, shelf space only grew by 1.5% annually over the same period. It created a conflict between limited shelf space and the trend toward greater product variety (Hübner, 2011). Meanwhile, providing product variety on the internet is associated with virtually unlimited shelf space (Um et al., 2013). Shelf space allocation has a direct effect on a retailer's profit to the extent that retailers allocate more space to products that give them the most profits, such as storable products (Zameer et al., 2012). Meanwhile, fast-moving consumer goods that are sold quickly and usually at a low cost, generate less profit (Hübner, 2011).

Wan et al. (2017) also addressed higher inventory levels as one of the operational problems arising from increased product variety and showed that information transparency and coordination with supply chain partners can provide relief. Cachon et al. (2005) associated the higher inventory costs with a greater variety of products. In the operations management literature, researchers describe that increasing diversity makes inventory management more difficult (Wan et al., 2012).

However, other authors rejected the idea that an increased product variety results in increased responsiveness (i.e. shorter lead time) due to the use of smaller batches (Moseley et al., 2017).

Summing up, chapter 2.1.2 delivers the following key insights:

- Nowadays, supply chains compete against each other, explaining why supply chain performance matters.
- Supply chains **with high product variety** tend to have **more complexities**.
- Finding a **trade-off** between the **positive and negative effects of product variety** is vital for supply chains. The keyword is “**useful variety**”.
- **Different measures of supply chain performance** may include:
  - customer satisfaction
  - costs incurred in the logistical process.
- Disadvantages of high product variety in supply chains include:
  - increased out-of-stock risk

- higher **supply chain complexities**
- poorer decision quality
- decreased fulfillment rates.
- The relationship between product variety and sales performance **builds on different functions**, e.g.:
  - inverted U-shaped curve
  - U-shaped curve

### ***2.1.3 Product variety in sustainable supply chains***

The constant increase in demand for products, as is evident from the trend towards increasing product diversity, negatively impacts the environment and society. According to the Triple Bottom Line business concept, firms should complement their financial performance measurement with the measurement of their business practices' implications on society and the environment.

Unfortunately, many organizations are skeptical about the net benefits of green practices to their business despite their potential to reduce costs and increase efficiencies, customer satisfaction, market share, and sales (Rajeev et al., 2017). Eco-friendly practices may inflict a positive impact on firm outcomes and enable it to deal with product variety. However, increased product complexity, which can be a result of product variety, presents an obstacle to the circular economy approach adoption in the supply chain.

Azevedo et al. (2011) examined the impacts of green supply chain management practices that allow firms to generate corporate profits while reducing environmental risks and impacts, producing competitive advantage, and showing environmental commitment (Rao et al., 2005). They also investigated the relationship between those practices and performance measurements in the automotive supply chain system. Ideally, GSCM practices cover all SC activities, from sustainable sourcing to reverse logistics, at strategic, tactical, and operational levels. The authors discovered that the implementation of green practices has a positive impact on operational performance in terms of "customer satisfaction" and "quality".

Rao et al. (2005) investigated companies in South East Asia and found that a green supply chain results in increased competitiveness and improved economic performance. While competitiveness is examined by considering the variables of improved efficiency, better quality, productivity increase, and cost savings, the variables of new market opportunities, product price increase, profit margin, sales, and market share form the basis to investigate economic performance.

Sahoo et al (2021) took a closer look at Indian manufacturers. They outlined the five dimensions of green supply chain management, which are internal environmental management, green purchasing, cooperation with customers, eco-design, and investment recovery. They also examined what effects these dimensions have on environmental, economic, and operational performance. Economic performance refers to the use of low-emission production facilities or the use of environmentally friendly materials. Operational performance means more efficient production and delivery to the customer. Economic performance focuses on how much the production facility can reduce costs related to waste, energy consumption, waste treatment, waste disposal, and fines for environmental accidents. In this regard, investment recovery, cooperation with the customer, and eco-design have a positive impact on environmental performance. Cooperation with customers and eco-design positively impacts operational performance. Unfortunately, the study did not find any direct positive impact on economic performance.

Zhu et al. (2007) investigated green supply chain management Practices at Chinese manufacturers and found that there is a higher implementation of green supply chain management within the industry electrical/electronics industry than in the other investigated industries, namely power generating, chemical/petroleum, and automobile. Results showed that higher levels of GSCM implementation led to improved performance outcomes. However, the same implementation levels of Green Supply Chain Practices led to different performance results in the industries examined. One reason for that outcome may be that some industries implemented green practices earlier than others.

Some studies dealt with how product variety affects performance when companies operate in an integrated green supply chain. Companies with complex products can improve their operational performance by adopting green supply chain management practices. Integrated green supply chain management helps minimize the overall environmental impact by successfully managing the upstream and downstream supply

chain (Galahitiyawe et al., 2019). The important operational environmental strategy (Zhu et al., 2012) serves as a mediating variable between product variety and operational performance. Therefore, the environmental cooperation of upstream and downstream parts of the supply chain makes a valuable contribution to the achievement of good operational performance regardless of the product variety levels (Galahitiyawe et al., 2019).

Product variety as such has some environmental considerations, e.g. the depletion of natural resources and the increase in waste in the ecosystem (Tang et al., 1996). Thus, firms must balance economic and environmental performance as well as find strategies to lower the environmental impact of their products and services in various phases like the product design phase where most of the environmental impact occurs because materials and processes are selected and the environmental performance of the product is determined to a large extent (Zhu et al., 2005). However, neither companies nor consumers care about the environmental problems associated with the high variety of products, while environmentalists call for consideration of environmental issues in product variety decisions. Promotional incentives promote new product variants and encourage waste as consumers keep buying new and improved versions of products. Marketing should not only refer to the fulfillment of sales-oriented corporate policy but also ecological factors. Esprit, for example, used its advertising and communication strategies to try to persuade consumers to consider whether they need the product before buying it. It persuaded them to find their style instead of following every fashion trend (Tang et al., 1996).

Many challenges may emerge due to the transformation or redesigning of the supply chain for the circular economy, a promising approach that encourages sustainability and competitiveness. A transition to the circular economy would have implications on product design, such as extending the product lifecycle or reverse logistics. The higher the product complexity or product range complexity is, the more difficult it is to implement renovation activities. These activities, including repair, reuse, or recycling, are parts of the circular economy (Bressanelli et al., 2019).

Sustainable practices are assumed to be important for firms in various industries. A study on the sustainable practices of slow and fast fashion firms discovered that green management plays an important role in both categories. Although one might assume that sustainability issues play a much bigger role for slow fashion companies whose business model is based on ecological fairness and sustainability (Schabasser, 2022).



Summing up, chapter 2.1.3 delivers the following key insights:

- The **product variety increase trend harms the environment in various ways**, such as increasing waste in the ecosystem and depleting natural resources.
- **Any attempt to redesign supply chain systems based on the circular economy concept** would affect the products offered by firms, for example through the extension of their lifecycle.
- **Eco-friendly supply chain practices** (e.g., sustainable sourcing, reverse logistics) may **positively impact supply chain outcomes**, e.g., due to increased customer satisfaction and quality.

Subsections 2.1.2 and 2.1.3 gave an overview of the complexity of today's supply chains due to the variety of products. It probably needs unique supply chain strategies that are different from those that manage traditional forecast-driven and inventory-based supply chains with long lead times (Christopher et al., 2004). Subsection 2.2 investigates fast fashion apparel supply chains and their role as the best practice in the industry.

## ***2.2 Fast Fashion Industry and its supply chains***

As presented in subsection 2.1.3., fast fashion is not a good example in terms of sustainability. However, it may serve as a best practice in terms of operational excellence and short lead times despite very challenging conditions.

The fast-fashion retail market has undergone considerable improvement over the past decade. As shown in Figure 1, stores like Hennes & Mauritz and Zara have become the key apparel retailers worldwide (Caro et al., 2015).

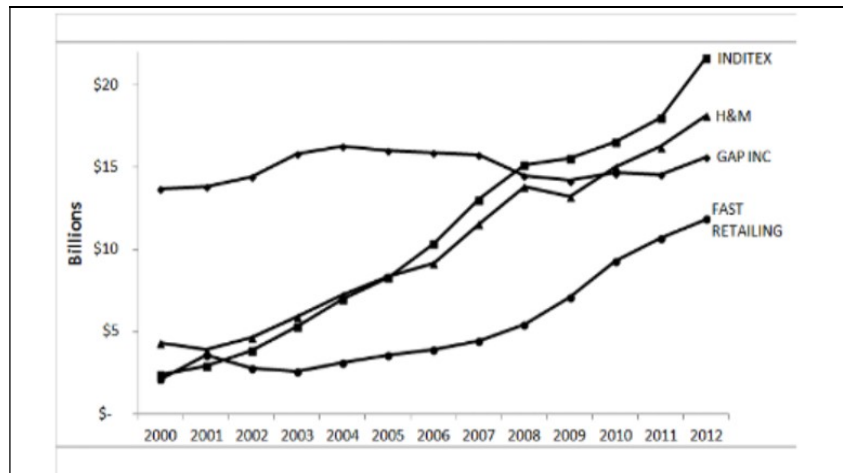


Figure 1: Apparel retailer revenue 2000-2012

Source: Caro et al. (2015)

Inditex, the world's biggest fashion group which owns eight fast fashion brands like Zara, Pull & Bear, and Inditex.com, reaches the Gartner Supply Chain Top 25 list due to its unequalled levels of agility and flexibility. It also understands customer value alongside efficient logistics, invests in technology to foster resilience, produces innovations, and performs well in environmental, social, and corporate governance (Gartner, 2021).

The characteristics of the fast fashion business model include short lead times, short life cycles, high volatility, low predictability, and high impulse purchasing. These characteristics pose challenges to logistics management (Christopher et al., 2004). Moreover, this business model enables firms to combine the elements of quick response, frequent assortment changes, fashionable designs at modest prices (Caro et al., 2015), proper time management, quick delivery, goods management, and inventory cost reduction (Tartaglione et al., 2013).

The term lead time refers to the time that spans between the phase of product design and the moment of its sale to the final consumer. According to Tartaglione et al. (2013), reducing lead times is achievable through the reduction of the time needed from identifying a market opportunity to distributing finished products on the market, including the period where the company distributes the products ordered by consumers to the stores and the period that the company needs to adapt its products to changing demand.

Increasing globalization and digitization ensure the rapid spread of trends, which increases the industry dynamics even more (Backs et al., 2020). Remaining competitive in a highly dynamic environment seems to be the watchword. The guiding forces behind the competitiveness in the challenging fast fashion apparel industry include the time needed to

market and design, marketing, and capital investment. The frequency of changes in inventories is a result of the high competitiveness of today's fashion market. (Bhardwaj et al., 2010). Products of the fast fashion business model are characterized by small-volume production and are available at stores for only a few weeks (Bucks et al., 2020).

Furthermore, demand is inherently unpredictable when it comes to highly fashionable products. Therefore, certain supply chains must accept uncertainties while creating a strategy that facilitates the matching of supply and demand. Firms need to develop an agile mode of management that can respond to “real-time” demand (Christopher et al. 2004) to survive in a volatile unpredictable marketplace (Christopher et al., 2001). While lean supply chain structures are highly suited for commodity products, agile supply chain structures are necessary to respond to the challenges of fashion products (Mason-Jones et al., 2000).

Christopher et al. (2004) provided a good roadmap for how to act in fast fashion supply chains, determining which structures fashion markets require to deal with volatile and turbulent demand. Agile supply chain strategies should be implemented in fashion markets because these are shorter and demand-driven supply chains. In contrast, conventional supply chains are longer and forecast-driven. Their study included the foundations for agility in a fashion business (e.g., being close to the customer and using point-of-sale data daily). Quick Response (QR) is an operational approach to serving a highly volatile fashion environment (Christopher et al., 2004). Agile supply chains are dedicated to one superior goal: reacting quickly to changes in demand to avoid supply shortages while providing an exceptional service level to the final customer. Therefore, the availability of goods creates a competitive advantage. The market success factors of this strategy include quality, cost, and total delivery time (Konecka, 2010). Recommendations or statements are based only on literature analysis or the author's previous work.

Firms may distinguish two product categories based on the demand patterns: primarily functional and primarily innovative. Each category needs a different type of supply chain. The failure of many supply chains may arise from a discrepancy between the type of product and the supply chain. While functional products satisfy people's fundamental needs, innovative products seek to satisfy customers' lifestyles and habitual needs. Fashion apparel is an obvious example of innovative products. A very important differentiator between functional and innovative products is the level of product variety.

The characteristics of functional products include their low product variety with ten to twenty variants per category, innovative products are known for their high product variety with often millions of variants per category. There are challenges innovative products need to cope with: the risk of shortages or excess supplies and the threat of obsolescence. The supply chain's market mediation function, or the capacity to ensure that supply meets demand, is predominant for this product type. Market mediation costs are the result of a mismatch between supply and demand which leads to lost sales opportunities or loss-making sales (Fisher 1997).

Fashion-conscious consumers want to acquire new styles in the stores as soon as possible, putting pressure on retailers, who, in turn, pass the pressure on to their suppliers as they should deliver with even shorter lead times. An important part of the "fast fashion" business strategy is to create an efficient accelerated supply chain that may respond adequately and fastly to emerging trends. The increase in complexity of supply chains affects the trend toward expanding product variety, a short product life cycle, greater outsourcing, and technological innovation. To cope with demanding consumers and overcome long buying cycles, strategic moves in terms of the supply chain have been introduced (Camargo et al., 2020).

The common characteristics of fast fashion supply chains include shorter lead times from designer to manufacturer, replenishment strategy, and vertical integration. In vertical integration, fast fashion retailers remain in control of design, manufacture, and delivery. It is an arrangement where a firm owns or controls more than one link in the supply chain. For example, a fast fashion retailer owns or controls its fashion suppliers, distributors, and retail locations. This agreement allows for shorter turnaround times, resulting in the likelihood of catching popular fashion trends (Abdulgadir et al., 2020). The Spanish clothing manufacturer Zara is a good example of vertical integration. The firm controls almost its entire supply chain, from design and production to global distribution (Guan et al., 2012). In contrast to traditional supply chains, the fifth component of slow fashion supply chains would be end-of-life-cycle treatment (Henninger et al., 2015) instead of waste (Schabasser, 2022).

Fast fashion supply chains require a high degree of flexibility. Flexibility, in turn, is a prerequisite for resilient supply chains. Resilience is extremely important considering the growing number of disasters over the past decades (Schabasser, 2021). The current trend in

the fashion industry moves toward increasing product diversity, a shortened product life cycle, the growth of outsourcing, and technological innovations. These factors would have increased the complexity of fast fashion supply chains (Camargo et al., 2020). The textile supply chain is inherently highly complex, consisting of multinational apparel retailers (customers), clothing manufacturers (suppliers), and suppliers (Suppliers to manufacturers) (Pamuk et al., 2018). Firms need to be aware of how much complexity they can handle without jeopardizing the efficiency of their processes. In today's complex supply chain environment, relationships between organizations in a supply chain may decide on profit or loss. The closeness to the market, which is guaranteed by local sourcing, makes fashion firms flexible as it enables them to adopt the latest market trends, shorter lead times, and faster deliveries (Veronesi, 2011).

Summing up, chapter 2.2 delivers the following key insights:

- The **fast fashion retail firms, such as Inditex**, have undergone **considerable improvement** over the past decade.
- Key characteristics of **fast fashion supply chains** are:
  - **short lead times**
  - short-life cycles
  - high volatility
  - low predictability
  - high impulse purchasing.
- **Agile supply chain structures** are recommended for the highly dynamic fast fashion apparel industry.
- Fashion apparel is a prime example of **innovative producers** with high product variety.
- Innovative producers such as fashion apparels face the following challenges:
  - the **risk of shortages or excess supplies**
  - the threat of obsolescence.
- **Relationships between firms in a supply chain** determine how profitable the chain is.

### 2.3 Executive summary of literature review

Table 2 provides an overview of some important points of literature as they raise further questions.

Table 2: Important sources of literature

Reference	Study aim	Findings/ Recommendations	Limitations	Questions arising
<b>Christopher et al. (2004)</b>	Clarifying the question regarding the adequate strategies for (fast) fashion businesses.	Agile supply chain strategies are recommended for fashion markets.	No data collection on which the recommendations are based.	Do the examined supply chain systems indicate agile strategies?
<b>Wan et al. (2017)</b>	Understanding the mediation relationship between product variety, forecast bias, and inventory level, proposing vertical integration as a mediator.	A reduction in forecast bias reduces inventory levels resulting from increased product variety. Vertical integration mitigates the negative effects of increased product variety on inventory levels.	The study mainly examines inventory performance measures and ignores soft performance measures.	What is product variety's effect on inventories in case of ongoing partnerships (instead of vertical integration)?
<b>Wan et al. (2012)</b>	Understanding the overall effect of product variety decisions on fill rate and sales.	Results show a non-linear relationship between product variety and fill rate on the one hand, and between product variety and sales performance on the other.	The study is limited to the two performance measures fill rate and sales performance.	What are the effects on performance (e.g., sales performance) if different product variant levels within a 1-year and a 3-year time frame are considered?
<b>Randall et al. (2001)</b>	Investigating the relationship between product variety, supply chain structure and firm performance.	Firm performance is improved when supply chain and product variety strategies are properly aligned.	The respondents' organizational roles are not diverse enough.	What are the results when the organizational roles of the respondents are more diverse?

<b>SerdarAsan (2013)</b>	Investigating different complexity drivers to which supply chains of different types are exposed to and presenting practices to deal with complexities.	Firms are more likely to employ complexity reduction strategies when dealing with static complexity (e.g., number of variety /interactions); firms tend to adapt processes to deal with dynamic complexity.	The classification of complexity drivers into static, dynamic and decision-making is not exhaustive. The drivers could also be categorized based on the origin of their generation (e.g., upstream/downstream).	In the cases examined, would it be advisable to reduce the number of products to reduce the complexity in the supply chain?
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*Source:* Author's table

## 2.4 Research gaps and hypotheses

While previous literature has investigated how product variety can affect firm and supply chain operational performance and suggests that high product variety may harm performance, no information is provided as to which performance measures are specifically affected by the high variety of products (Trattner et al., 2017). So, the author assumes that this distorts the communicated results. The existing study faces domain limitations due to the lack of analysis across different industries. Moreover, only a few studies have addressed the product variety–supply chain performance in green industries (e.g. slow fashion) and less sustainable industries (fast fashion) at the same time.

In addition, international supply chain management studies relating to product diversity are rare. While most studies focus on specific countries and regions, the number of studies that focus on developing countries is still minimum (Er, 2004). Thus, this review fails to provide a comparison of the perceived supply chain performance of different industries in different countries. However, it found that researchers often put more emphasis on the negative effects of product diversity than the positive effects. To gain a comprehensive understanding of product diversity, a more holistic approach would be helpful as it includes a consideration of the positive effects of product variety.

The topic of product variety benchmarking between different industries is also a rare topic among existing studies despite being an excellent tool for learning and understanding how influential product variety is to supply chain performance. Moreover, existing studies tend to focus more on covering investments in product diversity while ignoring other

strategic decisions. Nonetheless, it does not negate the point that product diversity has far-reaching effects at the company level as well as the supply chain level. The reviewed literature also often does not provide any information about the relationship that companies maintain with their supply chain partners despite the probability of a strong connection between the type of relationship and product variety.

The following hypotheses were developed based on literature review and first insights of respondent's supply chain systems. The hypothesis testing procedure takes place in chapter 4.

**H1<sub>0</sub>** An increase in product variety does not impact the performance of firms with more complex supply chains and their counterparts with less complex supply chains differently.

**H1<sub>1</sub>** An increase in product variety impacts the performance of firms with more complex supply chains and their counterparts with less complex supply chains differently.

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**H2<sub>0</sub>** A 1 to 4% product variety increase does not affect slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

**H2<sub>1</sub>** A 1 to 4% product variety increase affects slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

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**H3<sub>0</sub>** A 5 to 10% product variety increase does not affect slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

**H3<sub>1</sub>** A 5 to 10% product variety increase affects slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

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### 3. METHODOLOGY

The overarching goal of this doctoral thesis is to learn about the relationship between product variety and supply chain performance. Practices show that competitive firms develop a wide variety of products. At the same time, the literature shows that a high level of product variety has an impact on supply chain performance. The methods presented in this chapter help to answer the research questions and test the hypotheses of this study.

The methodology roadmap (see Table 3) explains the implementation of the international, cross-sector study. The study proceeded in three main steps: data collection, data analysis, and data interpretation.

As Table 3 shows, the research methodology is based on the conceptual modeling approach which helps examine and understand system structure, causality, and conditions. The method offers opportunities to express existing domain-specific knowledge (in this context, for instance, knowledge about the possible effects of product diversity on performance).

Furthermore, the questionnaires were integrated into a firm's newsletter of an association via a link, which was sent to all of its members (see table 3). It is an international, cross-industry questionnaire that fits the status of this study. A total of 485 respondents came from a rich and extensive database. Their responses were further analyzed using SPSS version 29. Non-parametric statistics, i.e., Chi-square, Mann-Whitney, and Kruskal-Wallis tests were used to evaluate the association of variables related to their supply chain systems with respondents' perceptions towards performance-related indicators (see table 3).

The following subchapters explain the components of the research methodology listed in Table 3 in more detail.

Table 3: Methodology roadmap

Data collection	Data analysis	Data interpretation
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">CONCEPTUAL MODELING APPROACH</p> <p>Literature review (mainly using databases ABI/INFORM Global, Google Scholar, Elsevier)</p> <p>Questionnaire consisting of <b>13 questions</b> where most of which adopted the <b>Likert-scale format</b>.</p> <p>Questioning people from different countries and industries with different supply chain functions, including decision makers from <b>fast and slow fashion businesses</b>.</p> <p>Identifying potential survey participants via associations, LinkedIn, snowball sampling etc.</p> <p>Using innovative ways to distribute the questionnaire (e.g., <b>linking it in the newsletters of networks</b> dedicated to supply chain management).</p> <p>Receiving the questionnaire results electronically via email, google forms or physically by post.</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">CONCEPTUAL MODELING APPROACH</p> <p>Respondents' supply chain are analyzed with <b>SPSS 29.0 (SPSS IBM)</b>.</p> <p><b>Mann–Whitney U-Test</b> to analyze if there are differences between two unrelated groups (e.g., group of respondents with more complex supply chains and that with less complex supply chains).</p> <p><b>x2 Test for Independence</b> to test whether there is a statistical connection between two categorical attributes, e.g. between type of business (e.g., slow and fast fashion business) and performance measures used. between type of business (e.g., slow and fast fashion business) and the reason for operating in the supply chain.</p> <p><b>Kruskal–Wallis H-test</b> to compare more than two independent samples, e.g., group with a high, medium, small level of joint supply chain planning regarding the ability to increase product variety without decreasing supply chain performance.</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">CONCEPTUAL MODELING APPROACH</p> <p>Assigning <b>meaning to nominal data</b>, e.g.</p> <ul style="list-style-type: none"> <li>- showing which industrial sectors are represented in the study</li> <li>- what type of relationship with supply chain partners is maintained (ongoing, collaborative, transactional)</li> </ul> <p>Assigning <b>meaning to ordinal data</b>, e.g.</p> <ul style="list-style-type: none"> <li>- How successful is the firm in managing its supply chain with values ranging from 1 to 5</li> </ul> <p><b>Recoding Likert Scale data</b> in some cases to increase readability, e.g.</p> <ul style="list-style-type: none"> <li>- strongly agree and agree were combined into one value, while strongly disagree and disagree were combined into another value)</li> </ul>

Source: Author's figure

### ***2.3 Domain-specific conceptual models***

This study employed the qualitative modeling method to foster an understanding of the domain and visualize and summarize the product variety and supply chain performance relationship. Furthermore, the utilization of the Garp3 workbench enhanced the visibility of the cause-effect relationship between product variety and supply chain performance (Bredeweg et al., 2009). The domain-specific knowledge formed in this study enabled it to better understand basic connections and create the basis for the questionnaire's development.

Furthermore, the stimulus for an increase in product variety stems from the heterogeneous needs of customers. In Figure 2, the fragment "A trigger for product variety" shows the connection between "customers," "supply chain," "product variety," and "drive." It also has the "influences" configuration, which represents the relationship between "customers" and "supply chain." "Drive" is characterized by the quantity space "zero, plus," and the quantity "product variety" has the quantity space "zero, plus." A positive direct influence ("I +") describes the causality between "drive" and "product variety." "I +" causes the following development of the quantities: if the current value of "drive" is positive, the "risk" increases; if "drive" has the value 0, then "risk" remains unchanged. Thus, the model fragment is consistently visible to the Garp3 engine since it does not link to any condition. The assumption is that "product variety" follows the development of "drive."

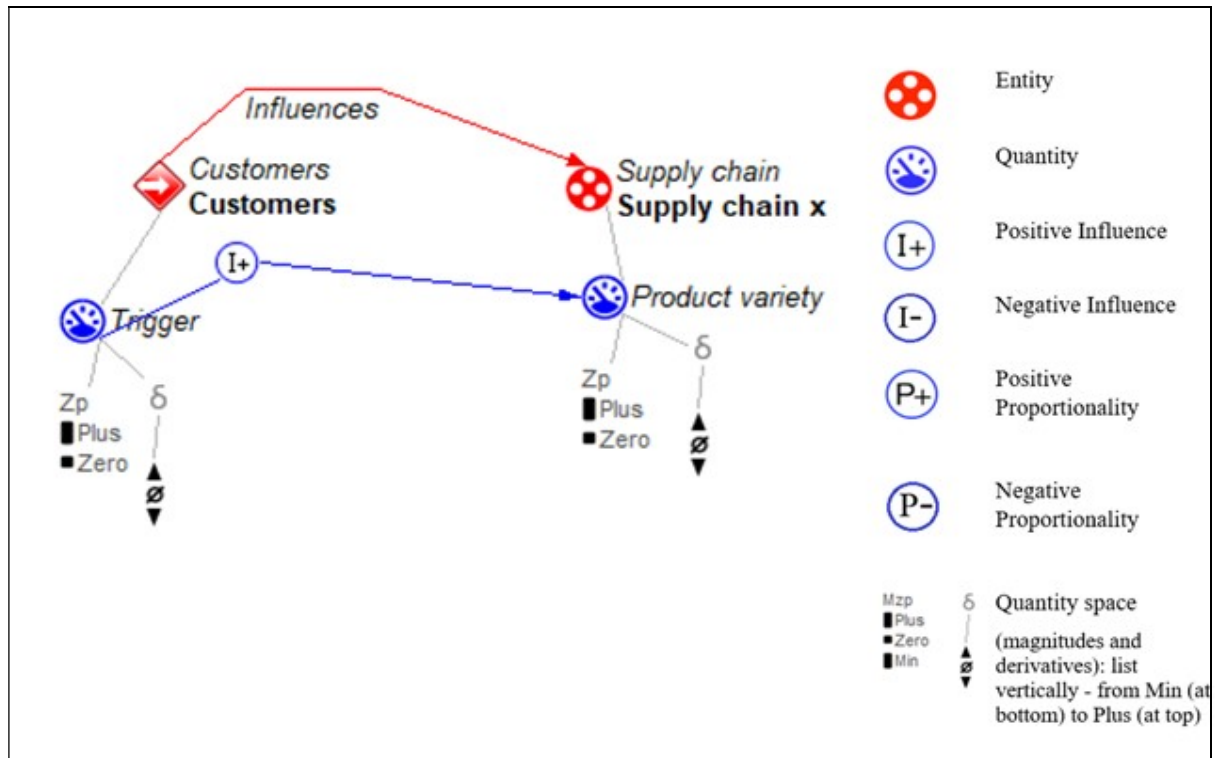


Figure 2: Conceptual modeling – Trigger for product variety

Source: Author's figure

Furthermore, the author employed a mathematical calculation (minus) to determine the "complexity rate" from the difference between "product variety" and "supply chain performance" in the "balancing mechanism" model fragment (see figure 3). The causal relationship between the quantities is described by a positive proportionality ("P +"), which leads from the quantity of "product variety" to the quantity of "complexity rate." "P +" means that the "complexity rate" increases when "product variety" increases, "complexity rate" decreases when "product variety" decreases, and "complexity rate" remains the same when "product variety" remains the same.

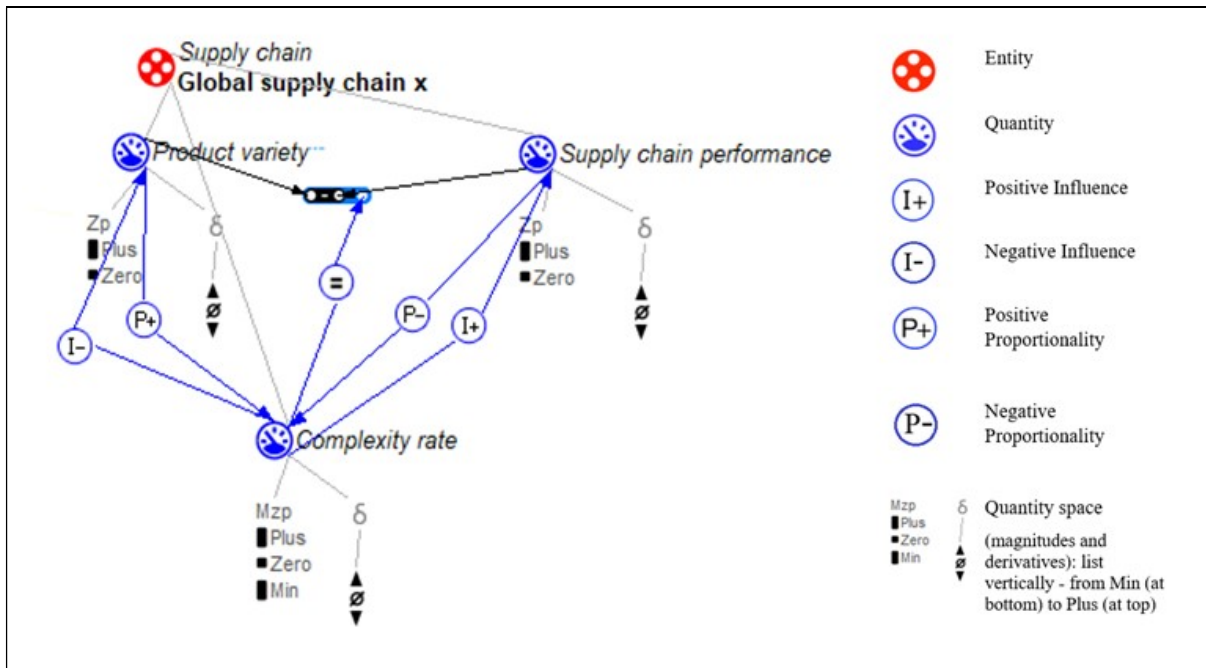


Figure 3: Conceptual modeling – Balancing mechanism  
Source: Author's figure

The purpose of this section is to analyze the simulation results. The value history from figure 4 presents the information about the development of the individual quantities. The shortest path {1 -> 2 -> 3 -> 4 -> 7} should be analyzed in more detail.

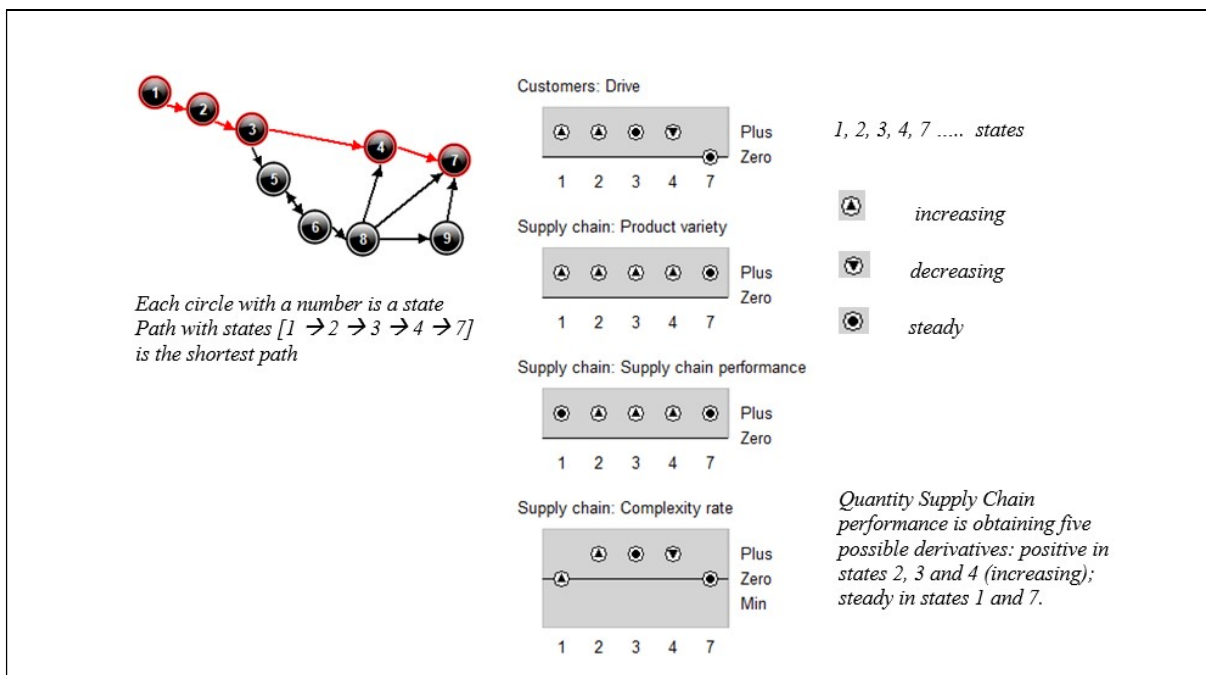


Figure 4: Conceptual modeling – Simulation results  
Source: Author's figure

“Drive” rises in states 1 and 2 and shows a downward trend in state 4 while stabilizing in state 7. The qualitative value of “product variety” increases in all states and stabilizes in state 7. The quantity “complexity rate” shows an increasing trend from state 1 to 2, decreases in state 4 and stabilizes in state 7. Figure 4 also shows that the quantity “supply chain performance” increases in states 2, 3 and 4 and stabilizes in state 7.

This example shows how much this type of discussion explains what happens when these variables develop in such ways.

### **3.1 Objectives**

This research method aims to create a cross-country and cross-sector study that can be used for benchmarking purposes. This goal can be achieved by interviewing people with different supply chain functions and interviewing people from different countries and industries.

Respondents with the following supply chain functions are represented:

- Member, representative or organizer of a supply chain manager association
- Scientific activity/research in the field of supply chain management
- Teaching activities in the field of supply chain management
- Currently in supply chain management training
- Completed training in supply chain management
- Supply chain function with management function (current or in the past)
- Supply chain function without management function (current or in the past)
- Other

As table 4 shows, a total of 20 different industry sectors are represented in the study. Respondents from the textile/clothing/leather, business services, retail and other industries are represented the most frequently.

*Table 4: Sectors of industry represented in the study*

		Frequency	Percent
Valid	Construction	22	4,5
	Electrical/Electronics	21	4,3
	Food/luxury foods (manufacturing of food and luxury foods and beverages)	39	8,0
	Health and social services	23	4,7
	Information and communication	22	4,5
	Metal/mechanical engineering	15	3,1
	Motor vehicle	13	2,7
	Other industries	76	15,7
	Personal Services	5	1,0
	Print/Paper	7	1,4
	Production and processing of glass, production of goods from stones and	2	,4
	Retail	55	11,3
	Textile/Clothing/Leather	59	12,2
	Tourism (accommodation and catering)	2	,4
	Traffic	8	1,6
	Agriculture and forestry	5	1,0
	Business Services	78	16,1
	Chemicals/Plastics	14	2,9
	Wholesale	17	3,5
	Wood/Furniture	2	,4
Total	485	100,0	

*Source: Author's table*

As already shown in table 3 in the methodology roadmap, the following steps are involved: data collection, data analysis and data interpretation, which aim to ensure the highest possible generalizability to different countries and industries.

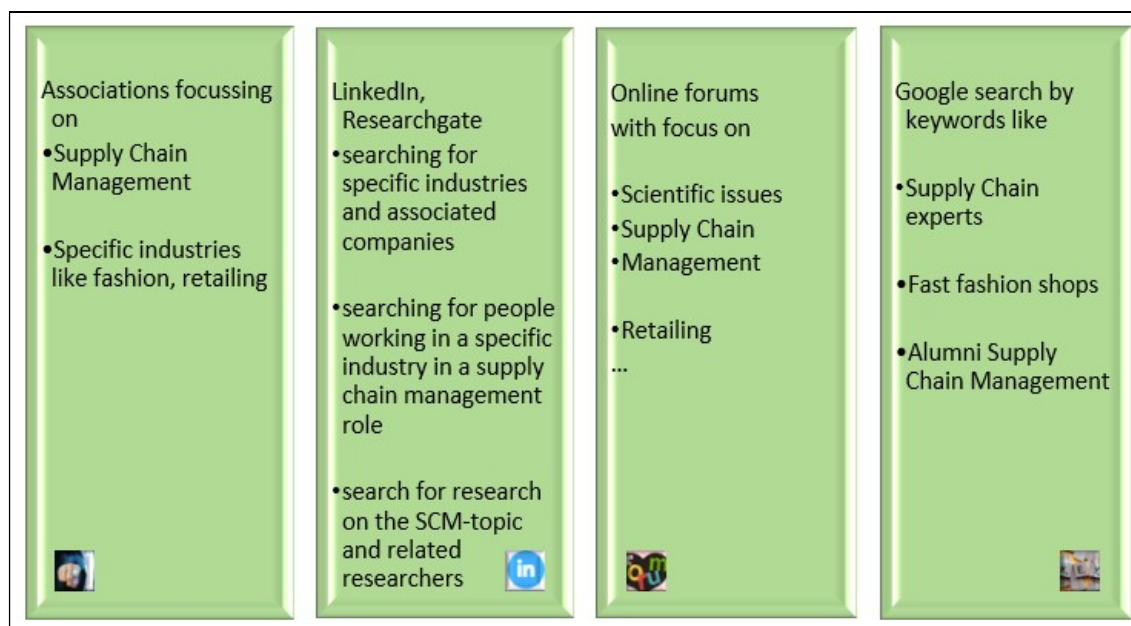
### **3.2 Data collection**

This study employed the quantitative research approach to describe and explain the phenomena of product variety and supply chain performance. Therefore, it collects numerical data and later analyzed it using statistics. The closed-ended questions in the questionnaire ensured the use of quantitative research methods. The research is therefore based on a realist or positivist worldview. The quantitative research approach helps to uncover the existing reality in terms of product variety and supply chain performance. The objective research methods helped to reveal the truth about the product variety – performance relationship. The approach enabled this study to find out how the sample thinks about the question being studied and to test the hypotheses. An important part of the

empirical part of work is benchmarking. Quantitative research also offered the ideal basis for the data collection activity as it allowed the segmentation of respondents. Such segmentation divided respondents into groups, including slow fashion firms, fast fashion firms, firms from the construction industry, firms from the foods industry, etc. (Sukamolson, 2007).

The survey utilized a self-administered questionnaire that contained a total of 13 questions. The procedure was that respondents could access a pdf version of the questionnaire with interactive checkboxes by opening the email sent to their inbox or clicking a link that led to the online version of the questionnaire.

Figure 5 illustrates the major respondents of the research. It is a subset of participants with characteristics relevant to the study. In the case of the present study, these are people performing a supply chain role, regardless of the industry. Due to a lack of information on all existing supply chains worldwide or in a certain region (e.g., DACH-region), it is impossible to conduct a census-based study (Martínez-Mesa et al., 2016).



*Figure 5: Survey participants*  
*Source: Author's figure*

The study makes use of several sampling types, which belong to the main group of non-probability sampling, as opposed to probability sampling, where it is equally probable for everyone in the population to be selected in the study (Acharya et al., 2013).



On the one hand, there is the snowball sampling, where the author asked the initial group of accurate individuals, as part of the invitation to the study, to forward the questionnaires to their network, more precisely to people who have similar or the desired characteristics (Martínez-Mesa et al., 2016). In addition, the quota sampling approach helped the study to ensure that a certain characteristic met the exact extent desired (Acharya et al., 2013). It required the fulfillment of enough participants who represent each respondent group to enable benchmarking between those groups.

Furthermore, social media as well as the mining of social media data also played a role here (Dusek et al., 2015). Using online social media to recruit survey respondents was an important and worthwhile approach since they represent a growing proportion of the population in many countries. A major advantage of participant recruitment via social media is the comparatively huge amount of meta information available on social media platforms (Kühne et al., 2020). For example, the author collected information on respondents' career information on social media to identify those working in the supply chain management area.

The business network platform LinkedIn was used to identify potential participants. This study utilized the LinkedIn company search feature (see figure 6) to browse for firms from the apparel and fashion industry (Dusek et al., 2015). The search results also displayed the link to the respective company website, allowing the author to send the invitation to participate to potential respondents' email addresses displayed on each firm's website.

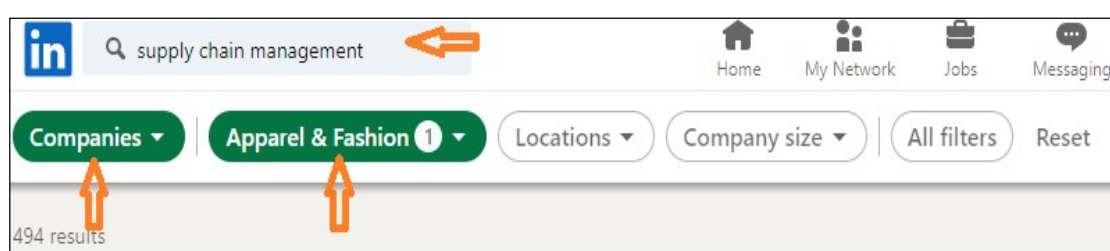


Figure 6: Identifying potential survey participants using LinkedIn

Source: Author's figure

Furthermore, the study also utilized LinkedIn's people search feature to identify people who have the necessary characteristics for participation in the study. The persons identified were usually contacted directly via LinkedIn and informed about the study. The author explained how they were selected, sent the link to the questionnaire, and asked them to participate due to their outstanding knowledge and expertise.

It is an international study; participants came from all over the world. The researcher, therefore, had to adjust to the problems associated with this internationality (Dusek et al., 2015), whereby it may be that the nationality of the respondent differed from their country of residence. International populations are regarded as so-called hard-to-reach populations. Factors such as colored questionnaires, personalization, and incentives probably influenced the response rate, regardless of internationality. However, the cultural and geographic distance between the sender and receiver has a major impact on the response rate. It is even assumed that the addressees would be more likely to participate if a local university supported the project. For example, it can be assumed that the higher the cultural distances, the lower the response rates (Harzing, 1997).

Researchers of international studies are therefore recommended to at least name the country from which the questionnaires were sent. It is also recommended to differentiate the response rates between the countries (Harzing, 1997). Care must be taken to ensure that participants from different countries react to the measurement scales, in the same way, otherwise, the reliability of the measurement is endangered (Mullen, 1995). The present work dealt with the problem with international studies mentioned in the literature in the following ways:

- The utilization of slight coral color for the questionnaire; just like in advertising, the questionnaire is a figurehead of the thesis. There is no evidence that the color coral conjures up negative associations in any culture.
- The mention of the researcher's country of origin in the invitation letter, specifically the researcher's study program, and the name and location of the university were mentioned.
- The explanation of the cross-cultural validity of the measurement scale and the five-tier Likert scale to eliminate the risk of misunderstanding.
- The differentiation of response rates based on the respondents' country of origin, enabled this study to react to noticeably low response rates in certain countries.

Certain surveys pose problems for researchers because of respondents' reluctance to cooperate. This could result in respondents not participating in the survey or participants not giving true answers to the questions. It is important to be aware of this issue. For example, topics are considered sensitive if participants would only answer the questions

(truthfully) if the questionnaire were anonymous. So, the researcher must consider the effect the survey has on participants (McNeeley, 2012). In the present study, it might be difficult for fast fashion firms to make statements about their supply chain performance. The reason is the bad reputation of the fast fashion industry. Participants may feel that the study initiator is only interested in criticizing the industry and wants to back this up with data. Participants coming from the fast fashion industry would be in a real dilemma between betraying their industry by truthfully answering the questions or restraining such a practice.

The assurance of anonymity when collecting or evaluating data helps to deal with this issue. Attention should also be paid to the wording of the survey description, as this affects the respondents' willingness to participate and their willingness to give accurate and honest answers (McNeeley, 2012).

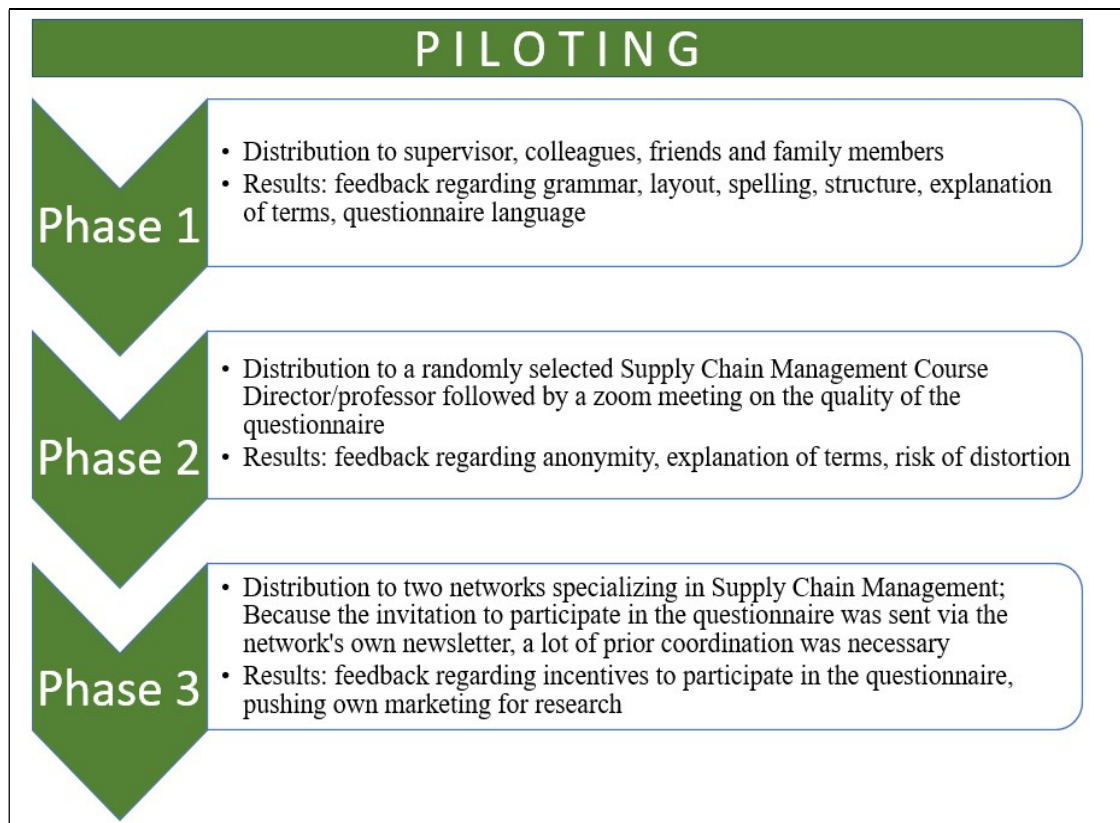
The survey employed both the assurance of anonymity and the conscious and accurate use of survey description to convince fast fashion firms to cooperate. In concrete terms, this meant that the invitation and study description for fast fashion participants included the following points:

- a notification stating that the fast fashion industry should act as a best practice example
- an emphasis on the positive features of the fast fashion industry
- an emphasis that the study needed participants from this industry because the research community, as well as practitioners, wanted to learn from this industry

To ensure a good response to the questionnaire, the piloting began and included 3 phases. In phase 1, the questionnaire was distributed to the supervisor, family, friends, and colleagues. It was possible to receive feedback regarding grammar, layout, and spelling as well as an explanation of terms. One of those feedbacks stated that the questionnaire should be available in English AND German (see figure 7 – Phase 1). The selected group from phase 1 alone could not reliably predict the emotional responses or comprehension difficulties of other groups. It is also important to realize the final sample should always be piloted on representative participants (Boynton, 2004).

The study carried out the quality assurance in phase 2 with a randomly selected supply chain management course instructor at a university. As an expert in the field of supply chain management, an increase in feedback was to be expected. Thus, the author managed to maintain the necessary anonymity. The recommendation was to create the questionnaire in google forms so the author could send anonymous questionnaire links to the potential participants. In this regard, another feedback asked for explanations of terms. The introduction to the questionnaire also suggested that this study should not deal too much with the topic of fast fashion, as this could lead to distortions in the answers due to the possible negative attitude towards fast fashion. According to the feedback, the introduction should be more neutral.

In phase 3 (see figure 7), the author contacted networks dedicated to supply chain management. Since they, like the professor from phase 2, agreed to distribute the questionnaire, a quality check was carried out. Before the attachment of the study and the link to the questionnaire in their newsletter, they shared suggestions for improvement. They suggested the creation of incentives for participation and how and where to best place them in the text. And they worked on a good introduction, i.e. an introduction to the research, for the newsletter. This idea might work in future contact with potential question participants.



*Figure 7: Questionnaire Piloting*

*Source: Author's figure*

In the survey start-up phase, the focus was equally on the people who did not participate in the survey as well as on those who did. Because from a scientific point of view, those who don't participate are equally important (Boynton, 2004) and the reasons for non-participation must be taken seriously.

The main reason for the cancellation was that there was a lack of time and resources. This was an opportunity to slightly correct the sentence that referred to the duration of completing the questionnaire. So instead of "maximum 10 minutes" it said between "approximately 5 minutes". That was one of the attempts to improve the response rate.

Another measure designed to boost response rates was incentive provision. Participants who took part in the survey may have the opportunity to win 1 of 3 vouchers worth EUR 50.00 which they can redeem in over 100 online shops. A small piece of chocolate was also included in the envelope of the questionnaire sent by post as a token of gratitude.

Since the piloting phase should also include a strategy on how to get the questionnaire to the participant and back again, the following strategies were determined for the present thesis (Boynton, 2004):

- The participants received the questionnaire sent by post. They could either send back the completed questionnaire by post or by e-mail.
- The participants received an e-mail containing the invitation to take part in the study and a link to the questionnaire; by following the link they could fill out the questionnaire and submit their answers online.

In both variants, the participants were assured of anonymity, which was more related to the evaluation of the questionnaires. Anonymity in the survey phase is not possible in the case of mailings.

To keep track of the questionnaire submissions that came via the link and to conclude response rates, the author created different forms in the survey management tool Google Forms (see figure 8). For example, the survey was filed under the form named "forums". In this regard, the advertisement of the research in scientific forums included the link to this exact form. Thus, the study may determine how many questionnaire participants it could gather through acquisition in forums.

There are some important reasons why the author chose Google Forms as the web-based survey tool, including (Narayanaswamy et al., 2016):

- free use of the tool
- limitlessness (regarding surveys and respondents)
- the survey responses and data are stored in so-called spreadsheets, facilitating the subsequent data preparation in SPSS



*Figure 8: Survey groups in Google forms*  
*Source: Author's figure*

## 4. MAIN FINDINGS

First, the results related to product variety and /or supply chain performance are presented.

### 4.1 First insights from a separate study

An initial online survey was conducted to provide preliminary insights into the potential relationship between product variety and supply chain performance, which is also a type of quality control. The survey only contained one question with four possible responses. Despite being less complex, the author expected the survey to provide meaningful results, reiterating the importance of addressing product variety and supply chain performance.

The literature has provided adequate information on the advantages and disadvantages of online research. Some advantages include speed (many surveys only require a short time to conduct), lower costs, visuality, flexibility, no presence of the interview required, anonymity, and perhaps a good fit with the tech-savvy lifestyle of the interviewee. Moreover, it does not involve any interviewer effect (Duffy et al., 2005). The interviewers play an important role in survey research, as they also influence the response behavior of the respondents, which can be a problem with non-self-administered surveys. Therefore, interviewers have a strong impact on the quality of the survey results, such as when they explain questions or administer complex questionnaires (Glantz et al., 2014). Since the recommendation is to carry out the fieldwork within a minimum timeframe to ensure good coverage, the present fieldwork was scheduled to finish in 14 days (Duffy et al., 2005).

The following question was asked to the 46.358 followers of the *Let's Talk Supply Chain* LinkedIn page:

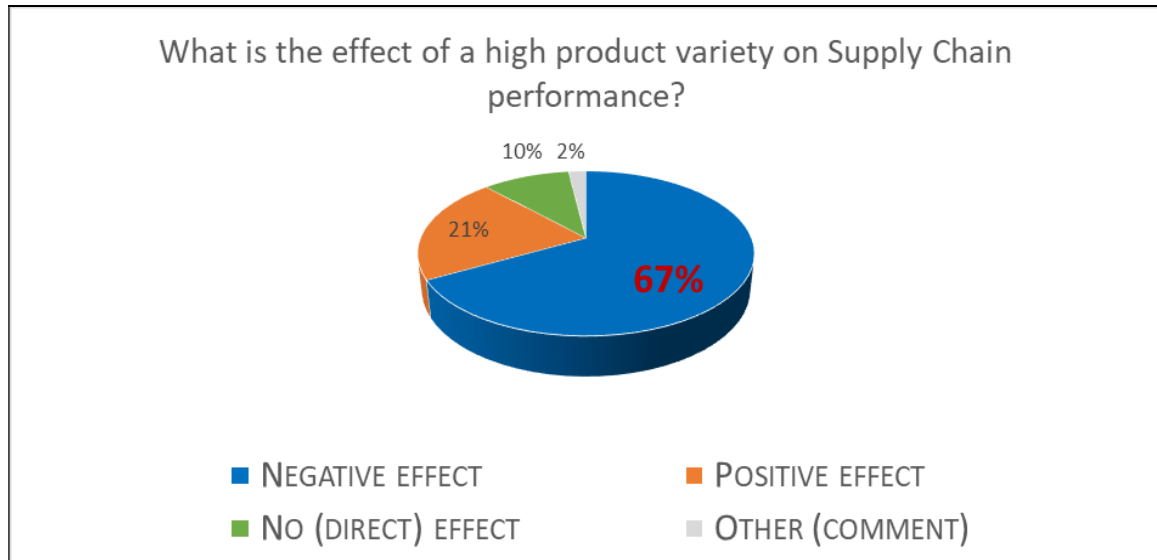
What is the effect of a high product variety on Supply Chain performance?

The participants had to choose one of the four possible answers: negative effect, positive effect, no (direct) effect, and other.

363 people took part in the survey.

The result of the survey corresponds to the insights that could be gained from the literature research. Most of the respondents (67%) believed that a large variety of products negatively corresponds with supply chain performance. 21% of respondents think there is a

positive relationship between product variety and supply chain performance. 10% of respondents believe that there is no (direct) effect between product variety and performance, while 2% of respondents had a different opinion and commented on it. Figure 9 summarizes the survey results graphically.



*Figure 9: Online poll “High product variety on Supply Chain performance”*  
*Source: Author’s figure*

The empirical evidence shows that respondents believed that a negative connection exists between product variety and supply chain performance. However, the study still needs to determine if different levels of increase in product variety affect supply chain performance differently. The survey aimed to close the gap.

#### 4.2 Data on respondents’ supply chains

The survey results show that respondents answered the questionnaire rationally because their answers aligned with the logical outcomes of other studies or were logically expected. However, some unexpected responses emerged. While the next chapter will discuss this situation in more detail, this section analyzes the data collected from the survey. **It provides a first assessment of the respondents' supply chain systems.**



### Customer satisfaction is the main reason for operating in a supply chain.

21% of respondents answered that they operated in a global supply chain because they experienced an increase in customer satisfaction, while 19% of respondents indicated that the operations increased their market share, and 17% of respondents said that such operations increased their core competencies (see figure 10). Other reasons for people's involvement in a supply chain are an increase in profits, a reduction of costs, improved productivity, and a reduction of inventory, as shown in figure 10.

The fact that the increase in customer satisfaction is one of the main reasons why companies are involved in a supply chain shows that the strategy's focus is on the customer for these respondents.

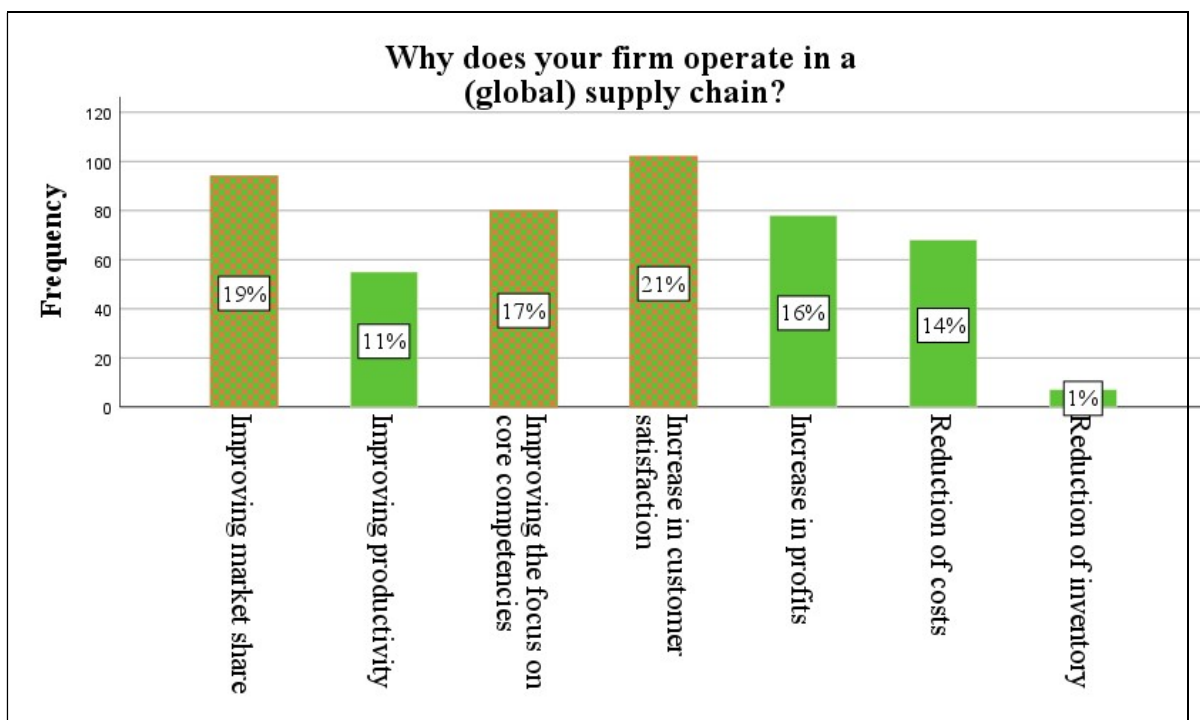


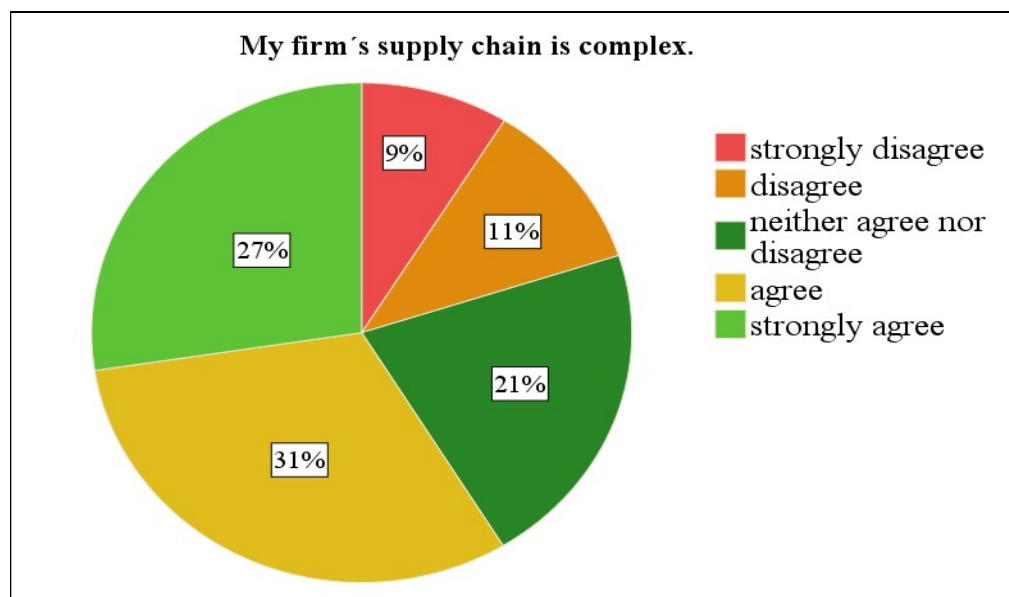
Figure 10: Reasons for operating in a supply chain

Source: Author's figure

### Most respondents regard their supply chains as complex.

The author assumed that respondents regarded the supply chain as a complex system. This assumption aligned with the conclusion of the Supply Chain Worldwide Survey, which discovered that 70% of surveyed companies perceived their supply chain systems as "very" or "extremely" complex (Geodis, 2017).

Figure 11 shows the answers of all respondents. 58% of respondents answered the question "My supply chain is complex" with "strongly agree" (27%) or with "agree" (31%). 21% of respondents answered the question with "neither agree nor disagree." The rest of the respondents answered "disagree" or "strongly disagree." Such empiric results fulfill the author's expectations. However, it remains intriguing to learn that 21% of respondents answered "neither agree nor disagree." It indicates that they could not determine the complexity level due to the lack of comparative value.



*Figure 11: Supply chain complexity*  
*Source: Author's figure*

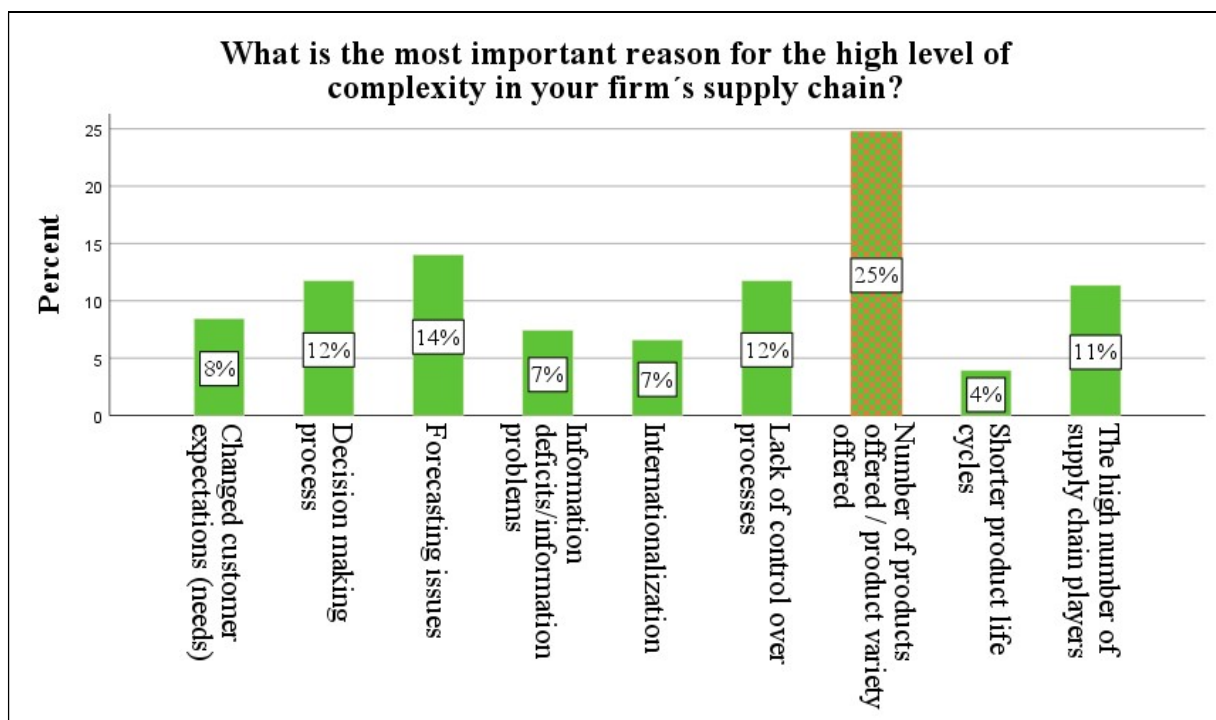
### **Product variety is THE reason for high supply chain complexity.**

The author had certain expectations for the survey responses regarding the question "what is the most important reason for the high complexity of the company's supply chain?". Supply chain complexity drivers are those factors in the supply chain that create complexity. Two types of drivers exist: static (structural) and dynamic (operational). These drivers, including the amount and variety of products, processes, suppliers, and customers, help firms understand the complexity of supply chain systems. Process uncertainties, unhealthy forecasts, market trends, and market uncertainties are examples of dynamic supply chain complexity drivers (Serdarasan, 2013).

The question of how to deal with supply chain complexity is different but equally important.

Managers should assess which complexities are unnecessary based on their value and usefulness for the supply chain system or firm while sustaining the necessary complexities (Serdarasan, 2013). Thus, the author expects that the complexities maintained by firms are useful and less problematic (Serdarasan, 2013). Drivers that the firm has little or no influence over (e.g., external drivers like various environmental factors) are possibly the biggest contributors to the high complexity due to their uncontrollability.

So, the author assumed that respondents would mention the reasons given in the questionnaire – "changed customer expectations (needs)" and "shorter product life cycles" – more frequently. 25% of the total respondents mentioned that the top driver of the high supply chain complexity is the level of product variety (see figure 12). This result contradicted Serdarasan's explanation, as she mentioned product variety as less complex due to its manageability (Serdarasan, 2013). However, the empiric findings outlined that product variety is too complex for respondents, whom they regarded unmanageable.



*Figure 12: Reasons for high supply chain complexity level*

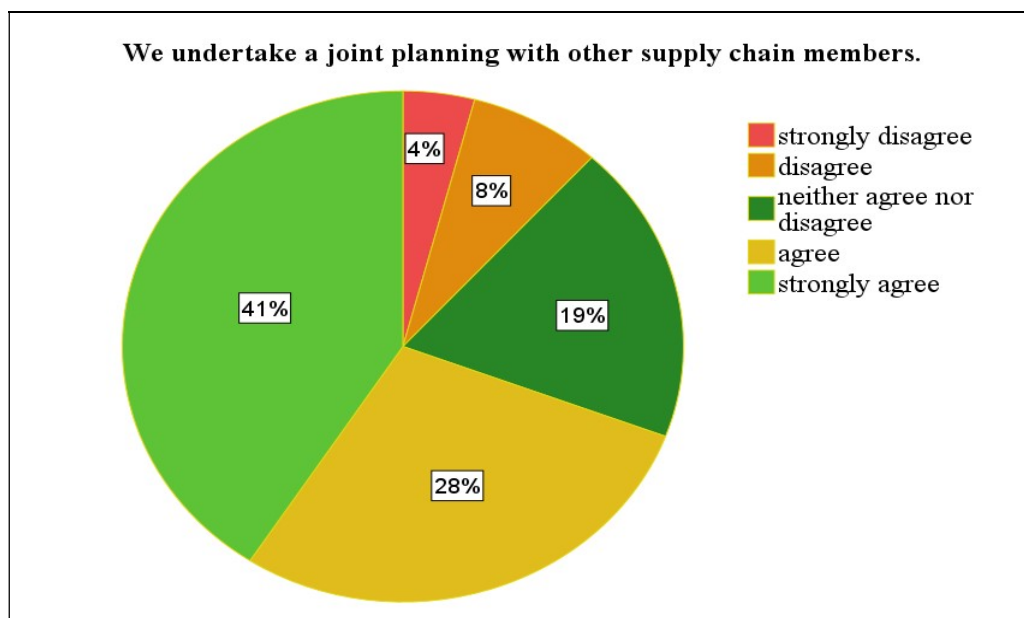
*Source: Author's figure*

### Respondents undertake a joint planning in the supply chain

Joint planning is one of the components of cooperation between supply chain partners. In joint planning, information sharing is crucial. It is difficult for partners to coordinate their operations and capacities without adequate information exchange. Supply chain partners also coordinate their goals and objectives. Planning supply chain operations together is the essence of a collaborative supply chain (Min et al., 2005). The author assumes that most respondents would answer that joint planning with supply chain partners is essential because, as the literature mentions, they must coordinate their operations.

Furthermore, the author assumed that the question was related to how respondents described their company's interactions with suppliers or (and) customers. The assumption is that there is a collaborative relationship between the partners when respondents answer that they are carrying out the joint planning mechanism.

69% of respondents answered "strongly agree" or "agree" to undertaking a joint planning mechanism with supply chain partners. Meanwhile, 19% of respondents answered "neither agree nor disagree," and the remaining respondents answered "strongly disagree" or "disagree" (see figure 13).



*Figure 13: Joint supply chain planning*

*Source: Author's figure*

In addition, the author also assumes that respondents who answered that they carried out a joint planning mechanism maintained a collaborative relationship with their supply

chain partners. Table 5 shows table percentages. It contains information regarding the supply chain relationship type (collaborative, ongoing partnership, other, transactional) and the joint planning efforts in the respondents' supply chain. According to the table, respondents who classified their supply chain as collaborative or an ongoing partnership had a joint planning mechanism with their supply chain partners or thought such a mechanism was necessary. The cells marked in orange, which show the highest values, indicate that the percentage values in each cell refer to the entire table. As shown in Table 5, 16.9% of a total of 485 respondents classified their supply chain relationships with their supply chain partners as collaborative while stating that they would establish a joint planning mechanism with their supply chain partners (answering the question "We undertake a joint planning with other supply chain members" with "strongly agree"). 16.1% of a total of 485 respondents classified their supply chain relationships with their supply chain partners as ongoing partnerships while stating that they would establish a joint planning mechanism with their supply chain partners (answering the question "We undertake a joint planning with other supply chain members" with "strongly agree").

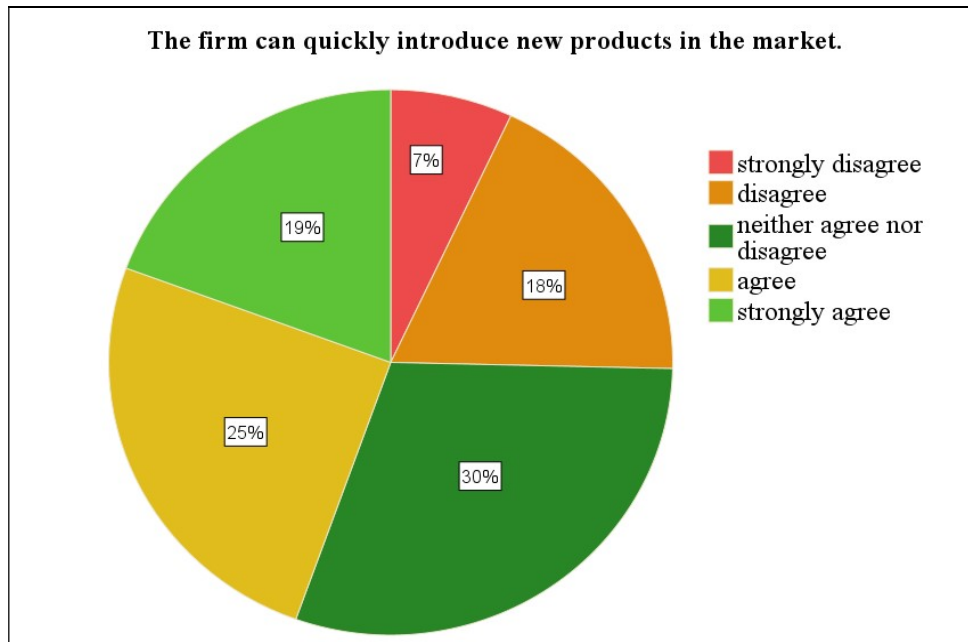
*Table 5: Firm's interactions and joint planning with supply chain partners*

		type of interaction with supply chain members			
		Collaborative	Ongoing partnership	Other	Transactional
		Table N %	Table N %	Table N %	Table N %
<b>We undertake a joint planning with other supply chain members.</b>	strongly disagree	0,8%	1,4%	0,6%	1,2%
	disagree	1,9%	3,5%	0,6%	1,6%
	neither agree nor disagree	7,4%	6,0%	0,8%	4,7%
	agree	11,8%	12,4%	0,8%	3,5%
	strongly agree	16,9%	16,1%	0,6%	7,2%

*Source: Author's figure*

### **Most respondents have an accelerated new product development**

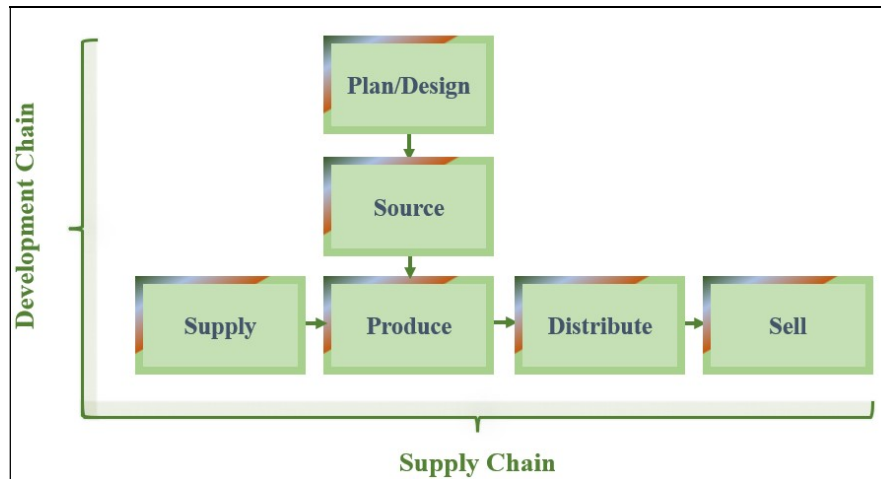
As shown in the pie chart (see figure 14), 44% of respondents answered "strongly agree" or "agree" to the statement "the firm can quickly introduce new products to the market". 30% of respondents answered "neither agree nor disagree", while 25% of respondents answered either "disagree" or "strongly disagree" with the statement.



*Figure 14: New product introduction*  
*Source: Author's figure*

Product introduction is a major potential source of competitive advantage and an opportunity for firms to reinvent themselves to meet evolving market conditions. Moreover, product development is the source of success, survival, and renewal for organizations (Brown et al., 1995). Product development and introduction require frequent adjustments to ensure effective and efficient delivery. To deliver products on target in terms of cost, time, and quality, it is advisable to align product development decisions with the supply chain system (Pero et al., 2010).

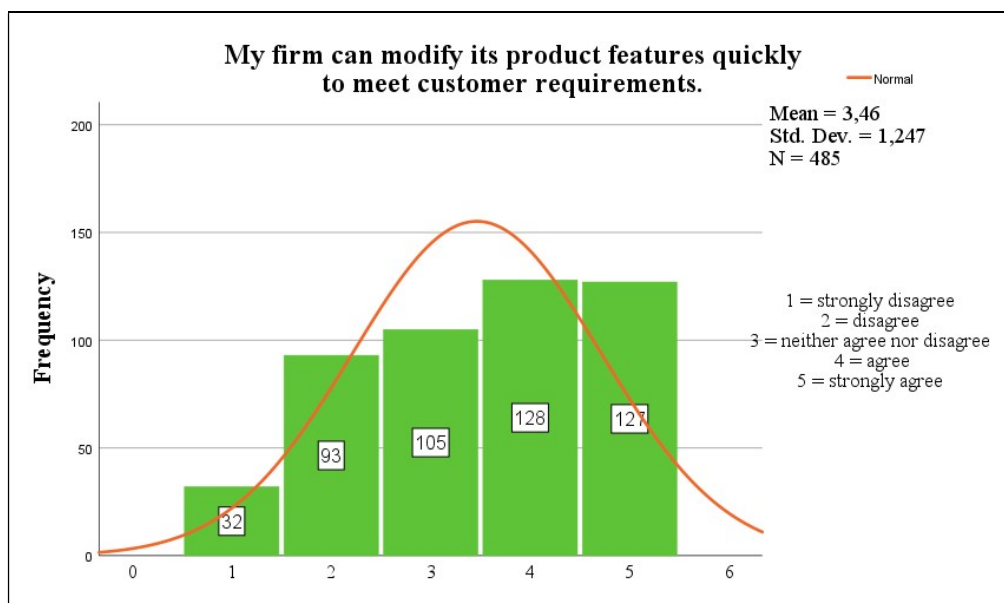
For those who disagreed with the statement "the firm can quickly introduce new products to the market," it might be advisable to consider making such an alignment. Simchi-Levi et al. (2008) coined the term "development chain" to draw people's attention to the production point where product development and the supply chain intersect (see figure 15). In this regard, the development chain serves as a collection of all the activities and processes associated with the launch of new products. Decisions made in the supply chain influence the development chain, and vice versa.



*Figure 15: Development and supply chain*  
 Source: Author's figure, following Simchi-Levi et al. (2008)

### Most respondents can accelerate product improvements

As shown by the histogram (see figure 16), the distribution is skewed to the left. It indicates there are fewer left-lying values and more right-lying values. The x-axis shows the values of the Likert scale. The mean is 3,46. Most respondents tended to agree with the statement "my firm can modify its product features quickly to meet customer requirements."



*Figure 16: Product modification*  
 Source: Author's figure

The study argues that product features impact supply chain performance. Therefore, researchers suggest redesigning the supply chain, such as the addition of product features,



as a possible option for adapting to changes in product variety. That is because different product variety levels affect the supply chain system differently. Various supply chain strategic decisions, supply chain structures, and the level of collaboration between supply chain members determine the level of impact of product features on supply chain performance. The alignment of supply chain features and product features ultimately determines how the supply chain system performs (Crippa et al., 2010). The fact that the majority of respondents stated that they can quickly change product features to react to new market requirements indicates an adequate alignment between product features and supply chain features.

### Respondents offer after-sales services

As demonstrated in table 6, the majority of respondents (69,7%) either "agree" or "strongly agree" with the statement "The supply chain can deliver value-added after-sales services." Only 3,9% of respondents strongly disagreed with this statement.

*Table 6: Product modification*

<b>The supply chain can deliver value-added after-sales services.</b>		
	Frequency	Percent
strongly disagree	19	3,9
disagree	47	9,7
neither agree nor disagree	81	16,7
agree	141	29,1
strongly agree	197	40,6
Total	485	100,0

*Source: Author's table*

Not only do after-sales services influence consumers' purchasing decisions, but they also serve as a key generator of revenue, profit, and competency for companies in modern industries that positively impact customer lifetime value. The question is whether the after-sales service offered by retailers and manufacturers in a two-stage supply chain fully satisfies target customers or not (Kurata et al., 2010).

Since the question referred to valuable after-sales services, it can be assumed that the majority of respondents preferred maximizing their profits while pursuing customer

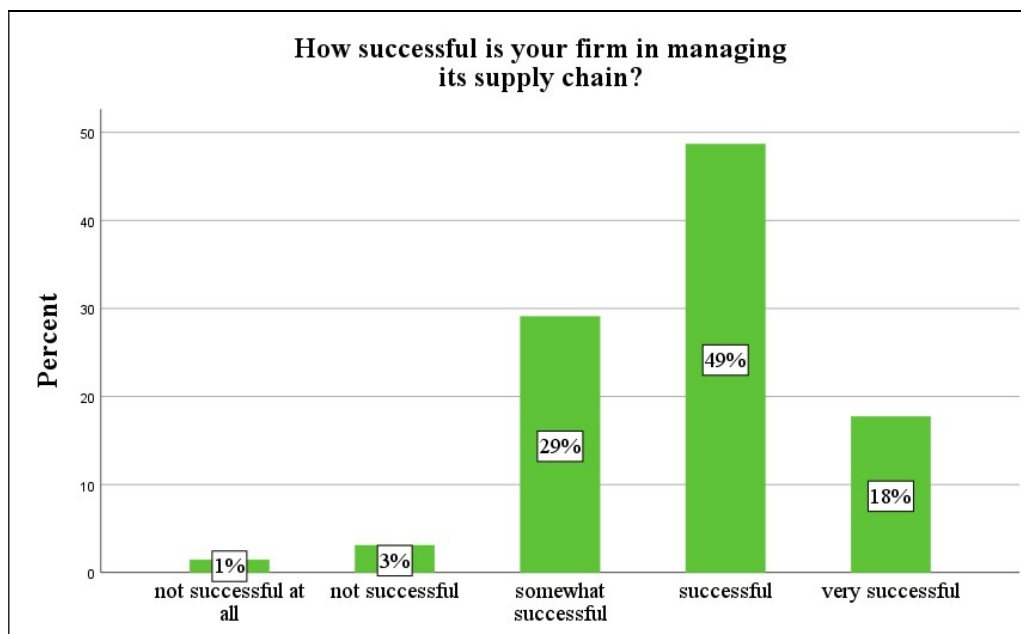


satisfaction through such services at the same time. A smaller proportion (13,6%) disagreed or strongly disagreed with regard to the question.

### **Respondent's supply chain management is frequently successful**

The responses to the question "How successful is your company in managing its supply chain?" are shown in figure 17. The Likert scale is plotted on the x-axis (1 = not successful at all, 2 = Not successful, 3 = Somewhat successful, 4 = Successful, 5 = Very successful). As shown in figure 17, a remarkable 49% of respondents think their supply chain management is successful and 18% even describe their supply chain management as very successful. A minority of 4% believe their supply chain management is either not successful at all or not successful.

In summary, it can be said that most respondents tended to regard their supply chain management as successful.



*Figure 17: Successful supply chain management*

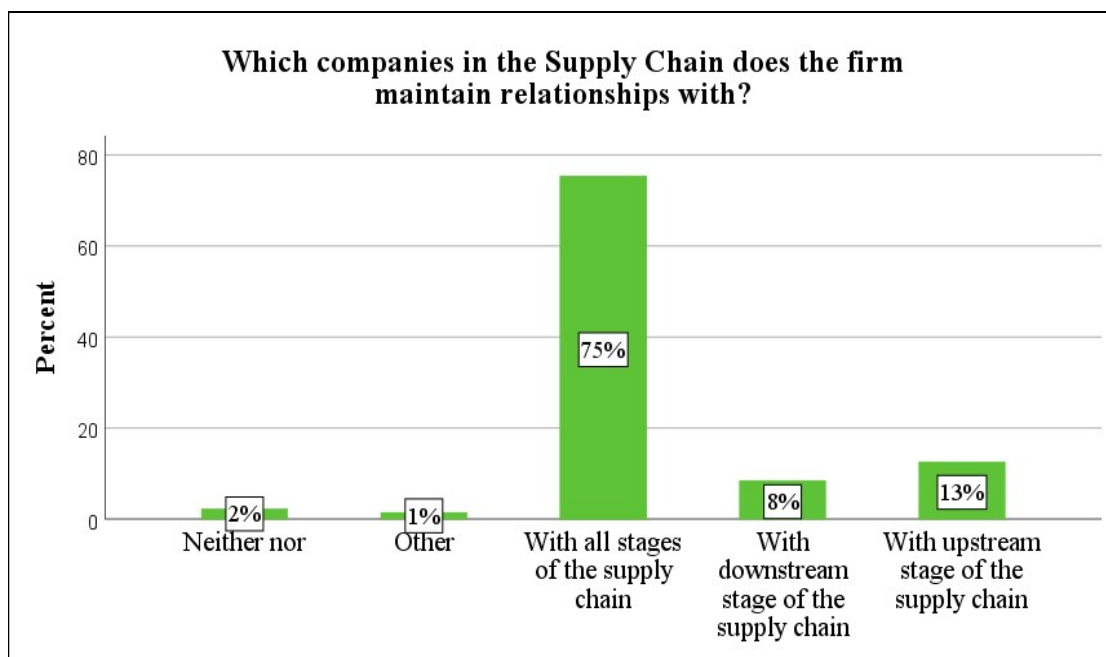
*Source: Author's figure*

### **Respondents maintain relationships with upstream and downstream SC stages**

Since competition today tends to take place between supply chains rather than between individual companies, cooperation between supply chain partners is important to

the establishment of stronger buyer-supplier relationships (Gu et al., 2022). As firms in a supply chain obtain materials from their suppliers, produce the product, and sell it to their customers, it is necessary to maintain relationships upstream with their suppliers and downstream with their buyers. Stability (but not exclusivity) in upstream and downstream relationships can increase the company's financial performance since it unlocks long-term partnerships. Stability means that suppliers and customers remain the same over time (Gu et al., 2022). Healthy relationships between upstream and downstream actors of the supply chain also enable them to respond accordingly to high demands for product variety (Nakandala, et al., 2019).

The study showed that a majority of respondents (75%) indicated that their company maintained relationships with both streams of the supply chain system (see figure 18). 13% of respondents stated that their firms only maintained relationships with the upstream of the supply chain, while 8% of respondents indicated that their firm maintained relationships with the downstream of their supply chain system.



*Figure 18: Supply chain relationships*

*Source: Author's figure*

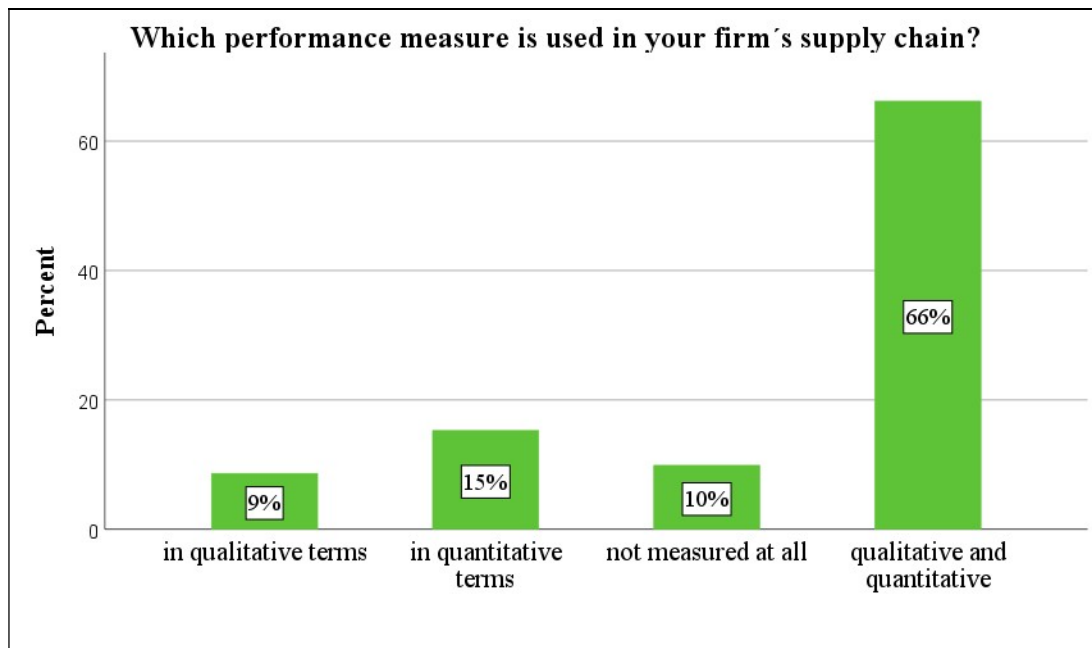
### **Most respondents use both qualitative and quantitative performance measures**

Beamon (1999) categorized performance metrics into two groups: quantitative (e.g., the total cost of resources used, the total cost of manufacturing, and costs associated with held inventory) and qualitative (e.g., customer satisfaction, information flow, supplier performance, and risk management). The complexity of a supply chain makes it challenging to select the appropriate performance measure.

According to Lee et al. (1992), many firms fail to meet adequate performance measures for the entire supply chain. Even when they have holistic metrics, they either lack regular monitoring measures or possess irrelevant metrics that are not geared toward customer satisfaction.

Unfortunately, cost reduction-based supply chain performance measures fail to maximize value for end customers (Simatupang et al., 2002), which is fatal since it is a supply chain's main objective (Brosch et al., 2011). Instead, they aim at minimizing individual costs. Performance metrics should deal with the big picture and measure the entire supply chain's performance rather than the performance of individual members only. When firms only focus on individual performance measures, they lose sight of the big picture (Simatupang et al., 2002).

As can be seen in Figure 19, the majority of respondents (66%) stated that they measure their supply chain in both qualitative (e.g., customer satisfaction) and quantitative terms (e.g., inventory costs). 15% of respondents responded that their firm's supply chain performance is measured in quantitative terms only, and 9% of respondents stated that their firm's supply chain is measured in qualitative terms only. It is worth mentioning that 10% of respondents stated that their supply chain performance is measured neither qualitatively nor quantitatively (see figure 19).



*Figure 19: Supply chain performance measure used*  
*Source: Author's figure*

If firms only perform qualitative or only quantitative measurements, as is the case with 24% of respondents (see figure 19), they shall ensure that the selected performance measures can adequately describe their entire system performance and that they meet criteria such as inclusiveness, universality, measurability, and consistency. A mixture of qualitative and quantitative performance measurements could be beneficial, as in the following example: A firm uses cost as the only performance measure for the supply chain. Fortunately, the supply chain is operating below minimum cost, so the firm may claim that its supply chain functions adequately. However, its potential poor performance in other areas may go unnoticed. If the performance is measured neither qualitatively nor quantitatively, as is the case with 10% of respondents, then they cannot measure the effectiveness of their supply chain system or benchmark their system with the best practices in the industry, causing them to lose the opportunity to identify potential areas to improve (Beamon, 1999).

### **Many respondents may have little agile supply chains**

As stated by Konecka (2010), agile supply chains are characterized by a quick reaction to changes in demand. The logical consequence would be that the firms would have fewer stockouts and be better able to fulfill their responsiveness. With the agile

strategy, excess inventory and potential bottlenecks are eliminated as much as possible. As table 7 below shows, for the majority of those surveyed, the risk of stockout increases as the variety of products increases. This could indicate that the majority of those surveyed do not have agile supply chains.

*Table 7: Effect of increasing product variety on risk of Stock-out*

<b>What is the impact of increasing product variety on the risk of Stock-out?</b>		
	Frequency	Percent
decreases	118	24,3
no effect	102	21,0
increases	265	54,6
Total	485	100,0

*Source: Author's table*

As can be seen from Table 8, respondents from the three groups – fast fashion, slow fashion, and others – argued that the stock-out risk increases as product variety increases. The intriguing finding is that a significant proportion of 41% of fast fashion companies (see Table 8) thought that the stock-out risk increases as product variety increases. It is surprising since it is the fast-fashion companies that often use agile supply chain strategies that should largely suppress such stock-outs.

*Table 8: Risk of Stock-out according to type of industry*

<b>What is the impact of increasing product variety on the risk of Stock-out? Answers classified according to sector of industry.</b>						
			TYPE OF INDUSTRY			Total
			OTHER	Fast Fash	Slow Fash	
Risk of Stock-out	decreases	Count	72	28	18	118
		% within type of industry	22,9%	35,9%	19,6%	24,3%
	no effect	Count	57	18	27	102
		% within type of industry	18,1%	23,1%	29,3%	21,0%
	increases	Count	186	32	47	265
		% within type of industry	59,0%	41,0%	51,1%	54,6%
Total	Count	315	78	92	485	
	% within type of industry	100,0%	100,0%	100,0%	100,0%	

*Source: Author's table*

A chi-square independence test with the following variables: "type of industry" and "risk of Stock-out" is carried out to determine if the type of industry is significantly associated with risk of Stock-out. The null hypothesis is: "There is no statistically significant association between type of industry and risk of Stock-out." The Pearson Chi-Square Asymp. Sig. (2-sided) shows that the p-value (0,008) of the test is less than 0.05 (see table 9). Therefore, there is a strong statistical significance for the relationship, and the null hypothesis can be rejected. It can be stated that there is an association between " type of industry" and " risk of Stock-out."

*Table 9: Chi-Square Tests – Risk of Stock-out and type of industry*

<b>Chi-Square Tests</b>			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13,880 <sup>a</sup>	4	,008
Likelihood Ratio	13,347	4	,010
N of Valid Cases	485		

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 16,40.

*Source: Author's table*

### **Well-performing compared to competitors**

Managers often overestimate the firm's performance. For example, a study found that managers overestimated the positive assessment and satisfaction of customers toward their products and services. Seeing the firm through rose-colored glasses may indeed lead to the wrong decisions. Therefore, too optimistic managers may overlook problems (Hult et al., 2016).

The optimistic disposition differs when comparing entrepreneurs, managers, and employees. Entrepreneurs are significantly more optimistic than managers, while managers are more optimistic than employees (Koudstaal et al., 2016).

The author assumes that many questionnaires are filled out by managers, and therefore, the author also assumes that they self-rate the performance of their firm's supply chains as good compared to other firms' supply chains.

A Likert scale – with extremely worse, worse, about the same, better, and extremely better scales – was used to allow respondents to compare their firm's supply chain performance in different areas with competing supply chain systems.

Figure 20 separates the answers according to slow fashion, fast fashion, and others. It shows that the mean value is at least 3 or above. Fast fashion companies rated their performance better than slow fashion companies compared to the competition in all areas surveyed. As can be seen in Figure 20, where the mean values range from 3,7 (ability to reduce the total cost of resources used) to 4,1 (ability to respond to and accommodate demand variations, such as seasonality).

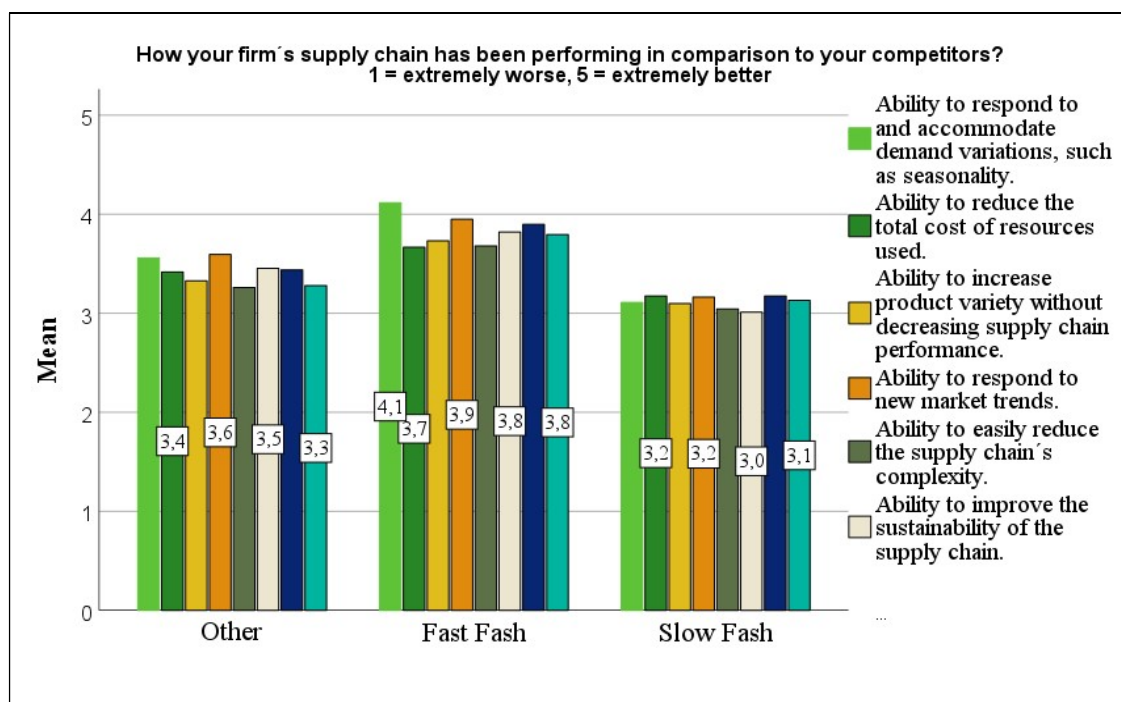


Figure 20: Supply chain performance by comparison

Source: Author's figure

The next paragraph analyzes the relationship between joint planning practices and the ability to increase product variety. For this purpose, a nonparametric statistical test called Kruskal-Wallis helped determine the statistically significant effect of independent variables (joint planning with other supply chain members) on the study's dependent variables (the ability to increase product variety without decreasing performance).

Tables 10 and 11 show the results of the Kruskal-Wallis test and reveal that joint planning with other supply chain members had a statistically significant effect ( $p = 0.033$ ) on the ability to increase product variety without decreasing performance (see tables 10 and 11). The test found significant differences at the  $p = 0.05$  level.

*Table 10: Kruskal-Wallis Test – joint planning and product variety increase*

<b>Ranks</b>			
<b>We undertake a joint planning with other supply chain members.</b>			
		N	Mean Rank
<b>Ability to increase product variety without decreasing performance.</b>	strongly disagree	20	265,02
	disagree	37	213,81
	neither agree nor disagree	92	224,72
	agree	138	229,07
	strongly agree	198	264,43
	Total	485	

*Source: Author's table*

*Table 11: Kruskal-Wallis Test Statistics – joint planning and product variety increase*

<b>Test Statistics<sup>a,b</sup></b>	
<b>Ability to increase product variety without decreasing performance in terms of replenishment lead time and cost.</b>	
Kruskal-Wallis H	10,480
df	4
Asymp. Sig.	,033

a. Kruskal Wallis Test  
b. Grouping Variable: 3.3 We undertake a joint planning (e.g. when a product variety increase takes place) with other supply chain members. How much do you agree or disagree with the statement: "There is a need for joint planning."

*Source: Author's figure*

This section outlines the summary of important information gathered from the survey. The majority of respondents:

- operated in a global supply chain to increase customer satisfaction.
- thought their firm's supply chain is complex.
- believed product variety increased the complexity of their firm's supply chain.
- performed joint planning with other supply chain members.
- argued firms can quickly introduce new products to the market.



- agreed with the statement “my firm can modify its product features quickly to meet customer requirements.”
- could deliver value-added after-sales services.
- regarded their supply chain management as successful.
- claimed they maintain relationships with both streams of the supply chain (downward and upward stages of the supply chain).
- measured their supply chain in qualitative and quantitative terms.
- probably have few agile supply chains.
- think they are performing quite well compared to competitors.

Now that an enormous amount of basic knowledge about the supply chain systems of the respondents has been gained, the hypothesis testing may start in the next chapter. The hypotheses were developed based on the literature research and initial insights from questionnaires. A refining of the hypotheses took place after the empirical results of the present chapter were available.

### 4.3 Discussion of results

Now the hypotheses described in chapter 2.4 are to be tested.

To make it clear once again, the hypotheses H10 and H11 are:

**H10** An increase in product variety does not impact the performance of firms with more complex supply chains and their counterparts with less complex supply chains differently.

**H11** An increase in product variety impacts the performance of firms with more complex supply chains and their counterparts with less complex supply chains differently.

Before the result is considered for group differences (complex and less complex supply chains), an overview of the answers to the question "What is, in your opinion, the impact of increasing product variety on the following aspects of supply chain management?" should be given. The areas queried ranged from the efficiency of the flow of information to product quality (see table 12). The answer options were decreases (0), no

effect (1), and increases (2). Table 12 summarizes the answers, not yet dependent on classification into groups.

*Table 12: Product variety increase on performance-relevant indicators*

		Count	Subtable N %		Count	Subtable N %	
7.1 Efficiency in flow of information in the supply chain	decreases	138	28,5%	7.7 Risk of Stock-out	decreases	118	24,3%
	no effect	103	21,2%		no effect	102	21,0%
	increases	244	50,3%		increases	265	54,6%
7.2 Efficiency in flow of materials in the whole supply chain	decreases	152	31,3%	7.8 Ability to change the quantity of orders to suppliers	decreases	140	28,9%
	no effect	72	14,8%		no effect	142	29,3%
	increases	261	53,8%		increases	203	41,9%
7.3 The reliability of the supply chain actors	decreases	164	33,8%	7.9 On-time delivery	decreases	163	33,6%
	no effect	109	22,5%		no effect	127	26,2%
	increases	212	43,7%		increases	195	40,2%
7.4 The delivery of zero-defect products	decreases	183	37,7%	7.10 Customer complaints	decreases	125	25,8%
	no effect	131	27,0%		no effect	157	32,4%
	increases	171	35,3%		increases	203	41,9%
7.5 The ability to rapidly improve responsiveness to changing market needs	decreases	113	23,3%	7.11 Product quality	decreases	100	20,6%
	no effect	62	12,8%		no effect	201	41,4%
	increases	310	63,9%		increases	184	37,9%
7.6 Response time (time between when a customer places an order and receives delivery).	decreases	156	32,2%	<p>What is, in your opinion, the impact of increasing product variety on the following, under points 7.1. to 7.11 listed areas? Possible answers: decreases, no effect, increases.</p>			
	no effect	120	24,7%				
	increases	209	43,1%				

*Source: Author's table*

The first analysis of the answers should present basic considerations as to why the results could look that way.

Regarding the effect of an increase in product variety on the **efficiency of the flow of information**, it can be explained as follows: A majority of 50% believed that increasing product variety increases the efficiency of information flow. What could be the reason for this answer?

Firms need to be more aware of their supply chain systems given that today's competition is less between companies and more between supply chains. An appropriate information-sharing capacity impacts the efficacy of the supply chain and is critically important for improving supply chain performance (Kumar et al., 2012).

An efficient flow of information is required to ensure the functionality of the supply chain. Supply chain management must ensure the flow of information (Badenhorst et al., 2013). Christopher et al. (1999) described in the late 1990s that supply chain management

must support the "flow of product and related as well as the upstream and downstream linkages with the respective supply chain partners. The supply chain management decision-making mechanism comprises five different areas: production, inventory, location, transport, and information, which supply chain members decide on individually and collectively. The sum of the decisions in all these areas ultimately determines the effectiveness of the entire supply chain. The information area enables the coordination of daily activities related to the other four key areas. Efficient information flow appears to be directly related to effective interoperability between various supply chain partners, such as systems that can communicate and share information both internally and externally. Interoperability ensures not only a faster flow of information but also an effective decision-making process. Trust between supply chain partners serves as a motor for a good, efficient flow of information (Badenhorst et al., 2013).

The following might be the reasons why 50% of the questionnaire participants believed that an increasing variety of products enhances the information flow efficiency:

- A very professional supply chain management that preserves control over its decision-making, including in the core area of information.
- Compatible information systems that enable an efficient exchange of information.
- Trusting relationships between supply chain partners.

As mentioned earlier, there is at least a theoretical link between the relationship between supply chain partners (e.g., trust) and information flow efficiency. At this point, it makes sense to consider the efficient flow of the supply chain with increasing product variety concerning the type of interaction with supply chain partners.

One question for the participants in the study was, for example, how they assess the company's interactions with suppliers and/or customers (in the broader sense). It is necessary to analyze if the participants, who viewed their relationships as collaborative or ongoing partnerships (both relationships are based on trust), responded that product variety enhances the efficiency of the information flow.

A chi-square independence test with the following variables: "efficiency of information flow in the supply chain" and "types of interactions with other supply chain members" is carried out to determine if the type of interaction is significantly associated with information flow efficiency. The null hypothesis is: "There is no statistically

significant association between "type of interaction with other supply chain members" and efficiency in information flow."

The statistic is based on a 3 x 4 crosstabulation table (see table 13).

*Table 13: Crosstabulation table – Efficient information flow and interactions*

		type of interactions with other supply chain members				Total
		Collaborative	Ongoing partnership	Other	Transactional	
Efficiency in flow of information in the supply chain	decreases	20,7%	30,4%	23,5%	41,6%	28,5%
	no effect	21,3%	18,8%	23,5%	25,8%	21,2%
	increases	58,0%	50,8%	52,9%	32,6%	50,3%
Total		100,0%	100,0%	100,0%	100,0%	100,0%

Source: Author's table

The value of the statistic is 18,933. The Pearson Chi-Square Asymp. Sig. (2-sided) shows that the p-value (0,004) of the test is less than 0.05 (see table 14). Therefore, there is a strong statistical significance for the relationship, and the null hypothesis can be rejected. It can be stated that there is an association between "type of interaction with other supply chain members" and "efficiency in information flow."

*Table 14: Chi-Square Tests – Efficient information flow and interactions*

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18,933 <sup>a</sup>	6	,004
Likelihood Ratio	19,328	6	,004
N of Valid Cases	485		

a. 2 cells (16,7%) have expected count less than 5. The minimum expected count is 3,61.

Source: Author's table

The ongoing partnership maintained by most of the respondents confirms the finding of Simatupang et al. (2004) that strict competition in the industry forces firms to collaborate with their upstream and downstream supply chain partners. The traditional "arm's length" partnerships are no longer relevant nowadays. According to a study by

Supply Chain Management Review and CSC, collaboration is ranked as the most pressing issue. The study showed that only approximately 35% of collaborative initiatives proved moderately successful (SCMR, CSC, 2004). True collaboration is not that easy to realize. This situation may be due to the lack of trust between supply chain partners or the lack of appropriate information exchange and communication platforms (Kampstra et al., 2006).

Given that most collaborative initiatives fail, one might think that supply chain partners are less likely to engage in collaborative initiatives. Consequently, one could assume that question 8 of the questionnaire was frequently answered "neither" or "nor," suggesting that the respondents preferred not to collaborate with the other firms in the supply chain. In truth, of the 485 respondents, 39% maintain a collaborative partnership with their supply chain members, 39% an ongoing partnership, 18% a transactional one, and the rest are distributed among "others."

Regarding the impact of an increase in product variety on the **efficiency of the flow of materials**, it can be explained as follows: A majority of 54% believed that increasing product variety leads to increased material flow efficiency (see table 12). Managing the flow of materials across the supply chain can be seen as a fundamental strategic success factor. Several factors influence such a flow, including the high costs involved in providing the required materials in the right quantity, in the desired form, in the right place, and at the right time at the lowest possible cost to end customers or supply chain members (Rao Tummala et al., 2006).

Effective supply chain performance requires adequate supply chain integration. A simplified material flow (e.g., by eliminating uncertainties in processes or by using the shortest planning periods that make management simpler) is the key to beneficial supply chain integration (Childerhouse, 2003).

- An increase in product variety affects the handling and flow of material. In terms of material supply, this means assemblers have to deal with a larger number of components and raw materials due to the greater variety of products (Brolin et al., 2017).
- High product variety leads to longer flow times and system inventory expansion. Managing product varieties that require different materials and components is highly challenging and may downgrade supply chain performance (Er et al., 2006).

The following reasons may lead questionnaire participants to believe that an increasing variety of products may enhance the material flow efficiency:

- Well-functioning supply chain management that also well-handles the core material transportation aspects.
- Prioritization of an efficient materials flow in the supply chain system.

Other factors that influence material flow efficiency include the type of relationship with other supply chain members. The following variables are tested for independence: "efficiency of material flow in the supply chain" and "types of interactions with other supply chain members." A strong statistical significance for the relationship was found ( $p = 0.011$ ), and the null hypothesis can be rejected. It can be stated that there is an association between "type of interaction with other supply chain members" and "efficiency in material flow."

Regarding the impact of an increase in product variety on the **reliability of supply chain actors**, it can be explained as follows: A majority of 44% (see table 12) believed that increasing product variety increases supply chain actor reliability.

Such a condition might be a sign that the supply chain is obviously well-prepared for new business challenges and does not get out of control so easily. It certainly has something to do with choosing the right supply chain strategy that can guide through such challenges. The members of the supply chain are probably very aware of the possible uncertainties and can handle them well. It is advisable to start with the free and transparent exchange of information and with comprehensive collaborative efforts as early as the product development phase, as this is a tried and tested means of preventing failure (Lee, 2002).

Regarding **zero-defect products**, a majority of 38% held the opinion that the delivery of zero-defect products decreases as product variety in the supply chain increases (see table 12). When asked how **product quality** behaves with increasing product variety, 41% think that increasing product variety does not affect product quality.

The stability of the supply chain process may lead to quality problems. It is possible that respondents who identified quality problems with increasing product variety were dealing with an evolving supply process, where both the manufacturing process and the

underlying technology are still in the development phase and are changing rapidly (Lee, 2002).

In this regard, the Variety Reduction Program (VRP) may facilitate quality improvement. This approach aims to reduce the number of parts and processes in a product and, thus, improve its quality. Such an approach resonates with the belief that every part and every process is the source of a potential error (Yeh et al., 1991).

Furthermore, 64% of respondents answered that increasing product variety enhances the ability to rapidly improve responsiveness to changing market needs (see table 12).

Understandably, firms offer a variety of products (e.g., broadening their product lines) to meet changing market requirements since changing and diversified customer tastes are one of the reasons why product variety is offered (Yeh et al., 1991). So, it can be concluded that most respondents met this goal. Product variety, according to 43% of respondents, increases response time (see table 12).

The following are several suggestions on how to make the lead time less susceptible to increases in product variety (Lee, 2002):

- Sharing and communicating important product-relevant information with suppliers (e.g. product rollover plans, product content information).
- Settling important suppliers on their sites to strengthen communication.
- Creating the possibility of real-time communication with supply chain partners to be able to respond quickly to potential mismatch problems.
- Using advanced internet-based solutions to exchange information and coordinate things like production schedules with supply chain partners.

Regarding **stock-out risk**, 55% of respondents answered that the stock-out risk in the supply chain increases with increasing product variety (see table 12). This result is astonishing since one could assume, as described in the literature, that greater product variety is related to higher inventory (Dubelaar et al., 2001).

One method to minimize such a strong impact is to manage fewer product varieties through the production of a generic product for as long as possible and move the so-called decoupling point as close as possible to the customer. One of the advantages of this postponement strategy is that the closer firms are to the end customer, the better they know

the true demand (Mason-Jones et al., 1999). This method also minimizes the volatility of demand that becomes a source of stockout risk.

As shown in Table 12, 42% of respondents believed that the **ability to change the number of orders to suppliers** increases with increasing product variety.

The result implies that the supply chains of respondents who saw a positive connection between the two variables were characterized by information transparency and collaborative behavior between their partners.

Regarding **on-time delivery**, 40% of respondents stated that on-time delivery increases with product variety.

It is beneficial for those responsible for the supply chain to be aware of the types of products. A different supply chain strategy fosters innovative products – that are characterized by a short life cycle, high product variety, and high demand uncertainties – more than functional products (Lee, 2002). It is likely that respondents who indicated that product variety enhances on-time delivery had the right supply chain strategy in place for their products.

This study further examined whether there are **differences in complex and less complex supply chains regarding an increase in product variety on the performance-related indicators**. The Mann-Whitney U-Test is used to determine whether there are differences between the two groups, "group with more complex supply chains" and "group with less complex supply chains," in their assessment of the impact of increased product variety on various supply chain-relevant areas ranging from supply chain efficiency to stock-out risk to product quality.

Various factors influence the complexity of supply chains. Supply chain complexity is determined by all organizations involved in the supply chain network flow (Huddiniah et al., 2019). So, in addition to product variety, numerous other factors influence supply chain complexity. Thus, there will be initial supply chain complexity regardless of the desire to increase product variety.

The analysis is interesting because two developments could now occur. On one hand, companies with a highly complex supply chain believed that an increase in product variety



does not affect the supply chain areas surveyed positively since they are already used to dealing with complexity. On the other hand, it could be that firms with less complex supply chains could perceive particular difficulties in the areas surveyed when increasing the variety of products.

The Mann–Whitney U-Test involves ranking data values (Corder et al., 2014). The variable "Supply Chain Complexity" with the 5-point Likert-scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) is converted into the following 2 scales: 1 and 2 strongly disagree with the statement, "My firm's supply chain is complex."; 4 and 5 strongly agree with the statement, "My firm's supply chain is complex." The respondents who answer "My firm's supply chain is complex" with "neither agree nor disagree" will not be included in the evaluation.

The question "what is, in your opinion, the impact of increasing product variety on the following aspects of supply chain management?" can be answered by 0 for decreases, 1 for no effect, and 2 for increases. If more respondents answered "increase", the rankings would be higher.

Table 15: Mann–Whitney U-Test for the groups complex and less complex SCs with ranks

	Ranks			
	SupplyChainComplexity_regrouped	N	Mean Rank	Sum of Ranks
7.1 Effect of an increase in product variety on the efficiency in flow of information in the supply chain.	GROUP 1: respondents with MORE COMPLEX supply chains	95	198,53	18860,50
	GROUP 2: respondents with LESS COMPLEX supply chains	277	182,37	50517,50
	Total	372		
7.2 Effect of an increase in product variety on the efficiency in flow of materials in the whole supply chain.	GROUP 1: respondents with MORE COMPLEX supply chains	95	203,66	19348,00
	GROUP 2: respondents with LESS COMPLEX supply chains	277	180,61	50030,00
	Total	372		
7.3 Effect of an increase in product variety on the reliability of the supply chain actors.	GROUP 1: respondents with MORE COMPLEX supply chains	95	210,27	19976,00
	GROUP 2: respondents with LESS COMPLEX supply chains	277	178,35	49402,00
	Total	372		
7.4 Effect of an increase in product variety on the delivery of zero-defect products.	GROUP 1: respondents with MORE COMPLEX supply chains	95	201,87	19178,00
	GROUP 2: respondents with LESS COMPLEX supply chains	277	181,23	50200,00
	Total	372		
7.5 Effect of an increase in product variety on the ability to rapidly improve responsiveness to changing market needs.	GROUP 1: respondents with MORE COMPLEX supply chains	95	192,94	18329,50
	GROUP 2: respondents with LESS COMPLEX supply chains	277	184,29	51048,50
	Total	372		
7.6 Effect of an increase in product variety on the response time (time between when a customer places an order and receives delivery).	GROUP 1: respondents with MORE COMPLEX supply chains	95	185,23	17596,50
	GROUP 2: respondents with LESS COMPLEX supply chains	277	186,94	51781,50
	Total	372		
7.7 Effect of an increase in product variety on the risk of Stock-out.	GROUP 1: respondents with MORE COMPLEX supply chains	95	162,55	15442,50
	GROUP 2: respondents with LESS COMPLEX supply chains	277	194,71	53935,50
	Total	372		
7.8 Effect of an increase in product variety on the ability to change the quantity of orders to suppliers.	GROUP 1: respondents with MORE COMPLEX supply chains	95	203,17	19301,00
	GROUP 2: respondents with LESS COMPLEX supply chains	277	180,78	50077,00
	Total	372		
7.9 Effect of an increase in product variety on on-time delivery.	GROUP 1: respondents with MORE COMPLEX supply chains	95	197,92	18802,00
	GROUP 2: respondents with LESS COMPLEX supply chains	277	182,58	50576,00
	Total	372		
7.10 Effect of an increase in product variety on customer complaints.	GROUP 1: respondents with MORE COMPLEX supply chains	95	164,96	15671,50
	GROUP 2: respondents with LESS COMPLEX supply chains	277	193,89	53706,50
	Total	372		
7.11 Effect of an increase in product variety on product quality.	GROUP 1: respondents with MORE COMPLEX supply chains	95	206,75	19641,50
	GROUP 2: respondents with LESS COMPLEX supply chains	277	179,55	49736,50
	Total	372		

Source: Author's table

Table 16: Mann–Whitney U-Test for complex and less complex SCs – Asymp. Sig

Test Statistics <sup>a</sup>						
	7.1 Efficiency in flow of information	7.2 Efficiency in flow of materials	7.3 Rreliability of the supply chain actors	7.4 Delivery of zero-defect products	7.5 Responsiveness to changing market needs	7.6 Response time
Mann-Whitney U	12014,500	11527,000	10899,000	11697,000	12545,500	13036,500
Wilcoxon W	50517,500	50030,000	49402,000	50200,000	51048,500	17596,500
Z	-1,367	-2,006	-2,676	-1,724	-,781	-,143
Asymp. Sig. (2-tailed)	,172	,045	,007	,085	,435	,886
a. Grouping Variable: SupplyChainComplexity_regrouped						
Test Statistics <sup>a</sup>						
	7.7 Risk of Stock-out	7.8 Changing quantity of orders to suppliers	7.9 On-time delivery	7.10 Customer complaints	7.11 Product quality	
Mann-Whitney U	10882,500	11574,000	12073,000	11111,500	11233,500	
Wilcoxon W	15442,500	50077,000	50576,000	15671,500	49736,500	
Z	-2,800	-1,871	-1,277	-2,423	-2,283	
Asymp. Sig. (2-tailed)	,005	,061	,202	,015	,022	
a. Grouping Variable: supplychainiscomplex_regrouped_mannwhitney						

Source: Author's table

The increase in product variety does not affect supply chain performance of firms with more complex supply chain and their counterparts with less complex supply chain differently based on the following performance-related indicators ( $\alpha > 0.05$ , therefore the null hypothesis must not be rejected):

- Efficiency in flow of information in the supply chain
- The delivery of zero-defect products
- The ability to rapidly improve responsiveness to changing market needs
- Response time (time between when a customer places an order and receives delivery).
- Ability to change the quantity of orders to suppliers
- On-time delivery

The increase in product variety affects supply chain performance of firms with more complex supply chain and their counterparts with less complex supply chain differently based on the following performance-related indicators ( $\alpha < 0.05$ , therefore the null hypothesis must be rejected):

- Efficiency in flow of materials in the whole supply chain

- The reliability of the supply chain actors
- Risk of Stock-out
- Customer complaints
- Product quality

Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted: "There is a tendency for one group (the group with the most complex supply chains) to rank significantly higher (or lower) than another (the group with the less complex supply chains) when it comes to the impact of an increase in product variety on the five mentioned performance-relevant indicators."

The analysis has shown the impact of product diversity on certain performance-relevant indicators. Some strategies (e.g., a manufacturing strategy) support increased product variety. An example of how firms fail to gain a positive impact from increasing their product variety is Toyota's Shatai subsidiary. In this regard, the increase in product variety affects the firm's productivity negatively since the manufacturing team had to spend much more time cleaning paint lines and changing tools (Berry et al., 1999).

Thus, a strategy that supports increased product variety shall incorporate the following considerations

- Carrying out a thorough analysis of investment required
- Examining the cost of adding product variety to make sound strategic decisions
- Raising awareness of the segment, e.g. low volume/high variety segments
- Investigating the profitability of product variants (e.g. ABC analysis), combinations of product features (feature-variant-matrix), or removing non-profitable product variants (variant reduction) (Braun et al., 2017)

Here again the result of the testing of the first Hypothesis:

- Respondents with less complex supply chains rated the

- efficiency in flow of materials in the whole supply chain to increase more through product variety increase compared to respondents with more complex supply chains.
- reliability of the supply chain actors to increase more through product variety increase compared to respondents with more complex supply chains.
- product quality to increase more through product variety increase compared to respondents with more complex supply chains.
- Respondents with more complex supply chains rated the
  - risk of Stock-out to increase more through product variety increase compared to respondents with less complex supply chains.
  - customer complaints to increase more through product variety increase compared to respondents with less complex supply chains.

Now the hypotheses described in chapter 2.4 are to be tested.

To make it clear once again, the hypothesis H20 and H21 are:

**H20** A 1 to 4% product variety increase does not affect slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

**H21** A 1 to 4% product variety increase affects slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

A chi-square independence test is carried out. Concretely, it should be tested if there is a significant difference between slow fashion, fast fashion, and other industries regarding:

- The effect of a 1 to 4% variety increase on the degree of an expected change in FINANCIAL performance within a 1-YEAR-TIME frame.

- The effect of a 1 to 4% variety increase on the degree of an expected change in FINANCIAL performance within a 3-YEAR TIME frame.
- The effect of a 1 to 4% variety increase on the degree of an expected change in QUALITATIVE performance within a 1-YEAR TIME frame.
- The effect of a 1 to 4% variety increase on the degree of an expected change in QUALITATIVE performance within a 3-YEAR TIME frame.
- Type of industry” and “The effect of a 1 to 4% variety increase on the impact on the FIRM’S SUPPLY CHAIN.

Table 17: Crosstabulation– type of industry and 1 to 4 % PV increase on performance

		TYPE OF INDUSTRY					
		OTHER		Fast Fashion		Slow Fashion	
		Count	Table N %	Count	Table N %	Count	Table N %
12.1 The effect of a 1 to 4% variety increase on the degree of an expected change in FINANCIAL performance within a 1-YEAR-TIME frame will be ..	None	21	4,3%	4	0,8%	8	1,6%
	Low	55	11,3%	4	0,8%	14	2,9%
	Moderate	93	19,2%	26	5,4%	32	6,6%
	Medium	103	21,2%	31	6,4%	31	6,4%
	High	43	8,9%	13	2,7%	7	1,4%
12.2 The effect of a 1 to 4% variety increase on the degree of an expected change in FINANCIAL performance within a 3-YEAR TIME frame will be ....	None	17	3,5%	3	0,6%	6	1,2%
	Low	51	10,5%	6	1,2%	11	2,3%
	Moderate	93	19,2%	13	2,7%	25	5,2%
	Medium	111	22,9%	36	7,4%	37	7,6%
	High	43	8,9%	20	4,1%	13	2,7%
12.3 The effect of a 1 to 4% variety increase on the degree of an expected change in QUALITATIVE performance within a 1-YEAR TIME frame will be ..	None	31	6,4%	3	0,6%	10	2,1%
	Low	57	11,8%	6	1,2%	13	2,7%
	Moderate	103	21,2%	20	4,1%	33	6,8%
	Medium	85	17,5%	35	7,2%	29	6,0%
	High	39	8,0%	14	2,9%	7	1,4%
12.4 The effect of a 1 to 4% variety increase on the degree of an expected change in QUALITATIVE performance within a 3-YEAR TIME frame will be ..	None	23	4,7%	3	0,6%	13	2,7%
	Low	52	10,7%	7	1,4%	7	1,4%
	Moderate	104	21,4%	19	3,9%	33	6,8%
	Medium	93	19,2%	31	6,4%	27	5,6%
	High	43	8,9%	18	3,7%	12	2,5%
12.5 The effect of a 1 to 4% variety increase on the impact on the FIRM’S SUPPLY CHAIN will be ..	None	25	5,2%	1	0,2%	3	0,6%
	Low	46	9,5%	5	1,0%	13	2,7%
	Moderate	77	15,9%	19	3,9%	33	6,8%
	Medium	104	21,4%	30	6,2%	31	6,4%
	High	63	13,0%	23	4,7%	12	2,5%

Source: Author’s table

The Pearson Chi-Square Significance for the variable “The effect of a 1 to 4% variety increase on the degree of an expected change in FINANCIAL performance within a 1-YEAR-TIME frame” shows that the p-value of the test is 0,161 and therefore bigger than 0.05. Therefore, there is no significant difference between slow fashion, fast fashion, and other industries statistical significance regarding the effect of a 1 to 4% variety increase on the degree of an expected change in FINANCIAL performance within a 1-YEAR-TIME frame.”

Therefore, an increase in product variety at the level described should not have significantly different effects on different types of industries. In this case, the null hypothesis "A 1 to 4% product variety increase does not slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently." must be accepted.

The null hypothesis can be rejected in 4 cases (see p-values of 0,043, 0,015, 0,11, and 0,14 in table 18). Therefore, it can be stated that there is a significant difference between slow fashion, fast fashion, and other industries regarding the effect of a 1 to 4% product variety increase on

- the degree of an expected change in financial performance within a 3-year time frame and type of industry.
- the degree of an expected change in qualitative performance within a 1-year time frame and type of industry.
- the impact on the firm's supply chain and type of industry.



Table 18: Pearson Chi-Square Tests for a 1 to 4% PV increase

Pearson Chi-Square Tests		Type of industry
12.1 ...the degree of an expected change in financial performance within a 1-year time frame will be ..	Chi-square	11,795
	df	8
	Sig.	,161
12.2 ....the degree of an expected change in financial performance within a 3-year time frame will be ....	Chi-square	15,985
	df	8
	Sig.	,043*
12.3 ...the degree of an expected change in qualitative performance within a 1-year time frame will be ..	Chi-square	19,006
	df	8
	Sig.	,015*
12.4 ...the degree of an expected change in qualitative performance within a 3-year time frame will be ..	Chi-square	19,924
	df	8
	Sig.	,011*
12.5 ...the impact on the firm's supply chain will be ..	Chi-square	19,174
	df	8
	Sig.	,014*

Results are based on nonempty rows and columns in each innermost subtable.  
\*. The Chi-square statistic is significant at the ,05 level.

Source: Author's table

Now the hypotheses H30 and H31 described in chapter 2.4 are to be tested.

**H3<sub>0</sub>** A 5 to 10% product variety increase does not affect slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

**H3<sub>1</sub>** A 5 to 10% product variety increase affects slow fashion, fast fashion, and other industries' financial (qualitative) supply chain performance in the short (1-year time-frame) and medium run (3-year time-frame) differently.

Results are presented in tables 19 and 20.



Table 19: Crosstabulation– type of industry and 5 to 10% PV increase on performance

		TYPE OF INDUSTRY					
		OTHER		Fast Fashion		Slow Fashion	
		Count	Table N %	Count	Table N %	Count	Table N %
13.1 The effect of a 5 to 10 % variety increase on the degree of an expected change in FINANCIAL performance within a 1-YEAR TIME frame will be ..	None	14	2,9%	1	0,2%	5	1,0%
	Low	36	7,4%	5	1,0%	11	2,3%
	Moderate	100	20,6%	19	3,9%	30	6,2%
	Medium	101	20,8%	34	7,0%	31	6,4%
	High	64	13,2%	19	3,9%	15	3,1%
13.2 The effect of a 5 to 10 % variety increase on the degree of an expected change in FINANCIAL performance within a 3-YEAR TIME frame will be ..	None	10	2,1%	0	0,0%	5	1,0%
	Low	40	8,2%	6	1,2%	9	1,9%
	Moderate	76	15,7%	20	4,1%	23	4,7%
	Medium	113	23,3%	29	6,0%	41	8,5%
	High	76	15,7%	23	4,7%	14	2,9%
13.3 The effect of a 5 to 10 % variety increase on the degree of an expected change in QUALITATIVE performance within a 1-YEAR TIME frame will be ..	None	20	4,1%	0	0,0%	4	0,8%
	Low	43	8,9%	6	1,2%	12	2,5%
	Moderate	92	19,0%	26	5,4%	32	6,6%
	Medium	103	21,2%	25	5,2%	31	6,4%
	High	57	11,8%	21	4,3%	13	2,7%
13.4 The effect of a 5 to 10 % variety increase on the degree of an expected change in QUALITATIVE performance within a 3-YEAR TIME frame will be ..	None	19	3,9%	2	0,4%	9	1,9%
	Low	39	8,0%	10	2,1%	9	1,9%
	Moderate	83	17,1%	20	4,1%	26	5,4%
	Medium	106	21,9%	24	4,9%	33	6,8%
	High	68	14,0%	22	4,5%	15	3,1%
13.5 The effect of a 5 to 10 % variety increase on the impact on the FIRM'S SUPPLY CHAIN will be ..	None	12	2,5%	0	0,0%	3	0,6%
	Low	40	8,2%	9	1,9%	13	2,7%
	Moderate	70	14,4%	16	3,3%	24	4,9%
	Medium	108	22,3%	29	6,0%	36	7,4%
	High	85	17,5%	24	4,9%	16	3,3%

Source: Author's table

The Pearson Chi-Square Significance shows that the p-value of the test is bigger than 0.05 for all variables (see table 20). Therefore, there is no significant difference between slow fashion, fast fashion, and other industries statistics regarding the effect of a 5 to 10% variety increase on

- the degree of an expected change in financial performance within a 1-year time frame.
- the degree of an expected change in financial performance within a 3-year time frame.
- the degree of an expected change in qualitative performance within a 1-year time frame.
- the degree of an expected change in qualitative performance within a 3-year time frame.
- the impact on the firm's supply chain.

*Table 20: Pearson Chi-Square Tests for a 5 to 10 % product variety increase*

		Pearson Chi-Square Tests	
			TYPE OF INDUSTRY
13.1 ...the degree of an expected change in financial performance within a 1-year time frame will be ..	Chi-square	8,658	
	df	8	
	Sig.	,372	
13.2 ...the degree of an expected change in financial performance within a 3-year time frame will be ..	Chi-square	11,131	
	df	8	
	Sig.	,194	
13.3 ...the degree of an expected change in qualitative performance within a 1-year time frame will be ..	Chi-square	11,782	
	df	8	
	Sig.	,161	
13.4 ...the degree of an expected change in qualitative performance within a 3-year time frame will be ..	Chi-square	7,270	
	df	8	
	Sig.	,508	
13.5 ...the impact on the firm's supply chain will be ..	Chi-square	7,803	
	df	8	
	Sig.	,453	
Results are based on nonempty rows and columns in each innermost subtable.			

*Source: Author's table*

Tables 18 and 20 showed that many respondents believe that an increase in product variety has a major effect on supply chain performance. That is because it may confuse customers due to the provision of too many product options, impacting both its qualitative (e.g., decreased customer satisfaction due to the excessive variety on offer) and financial performance (e.g., product variety due to an increase in costs). Customers may then decide against making a purchase. The following techniques may help to better identify the level of product variety that is attractive to the customer (Child et al., 1991):

- Grasping the essential requirements of downstream customers by interviewing experts or arranging workshops with customers.
- Evaluating the potential of existing products (e.g. product cannibalization, substitution).
- Redesigning the product range (e.g. cutting the existing product range or reconfiguring it by introducing new bundles of attributes).
- Communicating the value of lower product variety to customers (e.g. on-time delivery).

Another reason is the increase in complexity associated with a greater variety of products. In general, good performance should be achieved without producing an excessive number of products or generating countless material and information flows, because this can significantly increase complexity costs (Child et al., 1991). The following considerations are applicable in this context:

- Avoiding internal complexity caused by excessive product varieties
- Adopting procedures to keep internal complexity low, including Modular Product Design or facilitated handling techniques
- Implementing the postponement technique for managing product variety and coping with complexity (Trattner, 2019)

The following list sums up the chapter.

There is a positive correlation between product variety and

- Efficiency of information flow in the supply chain
- Efficiency of materials flow in the whole supply chain
- Reliability of supply chain actors
- Ability to rapidly improve responsiveness to changing market needs
- Response time
- Risk of stock-out
- Ability to change the quantity of orders to suppliers
- On-time delivery

There is a negative correlation between product variety and

- Delivery of zero-defect products

There is no connection between product variety and

- Product quality

There is a connection between the firm's interactions with suppliers and/or customers and the

- efficiency of information flow in the supply chain

- reliability of the supply chain actors

There is a difference between firms with more complex supply chains and those with less complex supply chains regarding the impact of an increase in product variety on the following performance-related indicators:

- Efficiency in flow of materials in the whole supply chain
- The reliability of the supply chain actors
- Risk of Stock-out
- Customer complaints
- Product quality

A 1 to 4% product variety increase affects slow fashion, fast fashion, and other industries on the following factors:

- the degree of an expected change in financial performance within a 3-year time frame and type of industry.
- the degree of an expected change in qualitative performance within a 1-year time frame and type of industry.
- the impact on the firm's supply chain and type of industry.

A 5 to 10% variety increase does not affect slow fashion, fast fashion, and other industries' statistical significance differently on the following factors:

- the degree of an expected change in qualitative performance within a 1-year time frame.
- the degree of an expected change in qualitative performance within a 3-year time frame.
- the degree of an expected change in financial performance within a 1-year time frame.
- the degree of an expected change in financial performance within a 3-year time frame.
- the impact on the firm's supply chain.

This study discovered a connection between the **performance measure used in the supply chain** (qualitative, quantitative, or a mixture of qualitative and quantitative) and **the success of the supply chain management**.

As shown in Table 21, respondents who utilized performance measures in their supply chains regarded their supply chain management to be more successful than those without performance measures. A majority of respondents that rated the question "How successful is your firm in managing its supply chain?" with "very successful" used both qualitative and quantitative performance measures (see table 21).

Table 21: Performance measure and SCM success

<b>How successful is your firm in managing its supply chain? Classified according to performance measure used.</b>						
% within QUESTION 4: Which performance measure is used in your firm's supply chain?						
		<b>performance measure used</b>				Total
		<b>in qualitative terms</b>	<b>in quantitative terms</b>	<b>not measured at all</b>	<b>qualitative and quantitative</b>	
How successful is your firm in managing its supply chain?	<b>not successful at all</b>		4,1%	6,3%	0,3%	1,4%
	<b>not successful</b>	4,8%	5,4%	8,3%	1,6%	3,1%
	<b>somewhat successful</b>	26,2%	33,8%	50,0%	25,2%	29,1%
	<b>successful</b>	52,4%	50,0%	31,3%	50,5%	48,7%
	<b>very successful</b>	16,7%	6,8%	4,2%	22,4%	17,7%
Total		100,0%	100,0%	100,0%	100,0%	100,0%

Source: Author's table

As can be seen from table 22, the p-value is much smaller than 0.05, and thus the null hypothesis can be rejected and the alternative hypothesis will be accepted ("There is a significant connection between performance measure used and supply chain management success").

Table 22: Chi-Square Tests – Performance measure and SCM success

<b>Chi-Square Tests</b>			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	49,926 <sup>a</sup>	12	<,001
Likelihood Ratio	48,809	12	<,001
N of Valid Cases	485		

a. 7 cells (35,0%) have expected count less than 5. The minimum expected count is ,61.

Source: Author's table

Another important scientific result refers to **supply chain integration**.

The first thing to examine is whether the investigated supply chain systems could also include integrated supply chains. Supply chain integration refers to the strategic collaboration between manufacturers and supply chain partners, the joint management of processes, the efficient interaction, and the joint decision-making to achieve effective and efficient product flows and value delivery to customers (Kang et al., 2018). Supply chain integration may offer the following advantages (Shou et al., 2017; Galahitiyawe et al., 2019; Khang et al., 2018):

- It facilitates knowledge and information transfer across supply chain partners.
- It ensures timely and accurate delivery of the required components and modules by suppliers.
- It improves the awareness of product demands if the integration also includes the customer.
- It integrates complementary knowledge across supply chain members.
- It enables competitive advantages development and therefore offers strategic relevance.
- It enables performance improvement.
- It facilitates the targeting of goals and responsiveness.

A higher level of product variety requires supply chain integration because it requires coordinated information exchange within the supply chain. It takes a certain level of integration to enable the transfer and sharing of information across organizations. In this regard, the integration enables the development of robust product portfolios with greater product variety (Galahitiyawe et al., 2019). The introduction of the product variety strategy increases the need for supply chain integration (Shou et al., 2017).

As shown in Chapter 4.2, most respondents describe their relationships with supply chain partners as collaborative. Therefore, it is safe to assume they maintain a certain degree of supply chain integration.

This study analyzes data using explorative data analysis to determine the significance of the product variety–supply chain integration relationship. The answers to the question "How would you characterize your firm's interactions with suppliers and/or customers?" may lead to a conclusion about the degree of supply chain integration. The assumption is that collaborative and ongoing partnerships indicate a higher level of supply chain

integration. Moreover, the answers to the question "Ability to improve product variety management in the supply chain (in comparison to other firms of the same industry)" tell about the dynamics of product portfolios (e.g., organizations with high product variety).

*Table 23: Supply chain integration and product variety management*

<b>How would you characterize your firm's interactions with suppliers/and or customers? Classified according to the level of ability to improve product variety management.</b>						
% within QUESTION 9: How would you characterize your firm's interactions with suppliers/and or customers?						
		<b>type of relationship with supply chain members</b>				
		<b>Collaborative</b>	<b>Ongoing partnership</b>	<b>Other</b>	<b>Transactional</b>	<b>Total</b>
Ability to improve product variety management in the supply chain compared to competition.	extremely worse	1,6%	2,6%	11,8%	5,6%	3,1%
	worse	8,5%	12,0%	23,5%	18,0%	12,2%
	about the same	29,8%	37,2%	23,5%	46,1%	35,5%
	better	42,0%	35,1%	11,8%	19,1%	34,0%
	extremely better	18,1%	13,1%	29,4%	11,2%	15,3%
<b>Total</b>		<b>100,0%</b>	<b>100,0%</b>	<b>100,0%</b>	<b>100,0%</b>	<b>100,0%</b>

*Source: Author's table*

As Table 23 shows, there is a significant connection between supply chain integration (determined here via the type of relationship) and product variety management, because the p-value is smaller than 0,05 (see table 24).

*Table 24: Chi-Square Test – supply chain integration and product variety management*

<b>Chi-Square Tests</b>			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	35,831 <sup>a</sup>	12	<,001
Likelihood Ratio	34,805	12	<,001
N of Valid Cases	485		

a. 4 cells (20,0%) have expected count less than 5. The minimum expected count is ,53.

*Source: Author's table*

Overall, a relationship between product variety and supply chain integration can be perceived.

Supply chain managers had better recognized the importance of sustainability, considering the increasing sustainability performance in the supply chain. They believed that sustainability practices impact environmental, social, and economic performance positively (Kang et al., 2018). **Sustainable supply chain management** plays a central



mediating role between product variety and supply chain performance. Galahitiyawe et al. (2019) found that organizations with product varieties need sustainable supply chain practices to improve operational performance.

This study employs the chi-square test to analyze the sustainable supply chain practices–firm performance relationship in firms with both high and low product variety levels. The analysis of the variables "ability to increase product variety without decreasing supply chain performance" and "ability to improve the sustainability of the supply chain" (see Table 25) shows a significant connection between these two variables; asymptotic significance is smaller than 0,001 and, therefore, smaller than 0,05 (see Table 26).

Based on this result, this study discovers a connection between the sustainability of the supply chain, product variety, and supply chain performance.

Firms understand the importance of collaboration across supply chain partners, the maintenance of relationships with different stages of the supply chain, and the role of supply chain integration. It confirms the importance of supply chain integration and sustainable supply chain practices for firms with a high level of product variety.

*Table 25: Supply chain integration and product variety management*

		Ability to improve the sustainability of the supply chain. Ability to increase product variety without decreasing supply chain performance.					Total
		% within 10.3 Ability to increase product variety without decreasing supply chain performance.					
		Ability to increase product variety without decreasing supply chain performance.					
		extremely worse	worse	about the same	better	extremely better	
Ability to improve the sustainability of the supply chain	extremely worse	45,5%	12,8%	2,3%	3,3%	3,2%	5,6%
	worse	18,2%	32,6%	13,2%	7,3%	6,3%	14,0%
	about the same	27,3%	38,4%	40,8%	25,8%	1,6%	30,3%
	better		10,5%	37,4%	43,7%	25,4%	32,2%
	extremely better	9,1%	5,8%	6,3%	19,9%	63,5%	17,9%
Total		100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Source: Author's table

*Table 26: Chi-Square test: supply chain integration and product variety management*

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	218,589 <sup>a</sup>	16	<,001
Likelihood Ratio	192,165	16	<,001
Linear-by-Linear Association	116,379	1	<,001
N of Valid Cases	485		

a. 7 cells (28,0%) have expected count less than 5. The minimum expected count is ,61.

Source: Author's table



This section examines the relationship between **supply chain integration and sustainable supply chain practices**. The literature describes supply chain integration as a factor that enables companies to implement sustainability practices that involve all supply chain system members. In this regard, suppliers have a vital role in these practices. For instance, they may get involved in the product development process. Thus, long-term, mutually trusting relationships between firms and their suppliers are essential requirements for sustainable practices. They are also enormously important during their transition to sustainability (Kang et al., 2018).

Table 27 provides some initial insights regarding the link between the ability to improve the sustainability of the supply chain and the implementation of an integrated supply chain system characterized by relationships among its members.

*Table 27: Supply chain sustainability and supply chain integration*

		How would you characterize your firm's interactions with suppliers/and or customers?				Total
		Collaborative	Ongoing partnership	Other	Transactional	
Ability to improve the sustainability of the supply chain.	extremely worse	2,7%	7,0%	11,8%	5,6%	5,6%
	worse	12,2%	9,4%	17,6%	27,0%	14,0%
	about the same	25,5%	32,5%	11,8%	39,3%	30,3%
	better	35,6%	38,2%	23,5%	13,5%	32,2%
	extremely better	23,9%	12,0%	35,3%	14,6%	17,9%
Total		100,0%	100,0%	100,0%	100,0%	100,0%

*Source: Author's table*

*Table 28: Chi-Square Test: supply chain sustainability and supply chain integration*

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	49,760 <sup>a</sup>	12	<,001
Likelihood Ratio	50,669	12	<,001
N of Valid Cases	485		

a. 4 cells (20,0%) have expected count less than 5. The minimum expected count is ,95.

*Source: Author's table*

It is intriguing to learn that there is a significant relationship between supply chain integration (characterized by collaborative and ongoing relationships among supply chain members) and sustainability of supply chain.

To leave no room for free interpretation, the types of possible relationships that occur in the study are explained here:

- Transactional: This type of collaboration focuses on demand and supply between supply chain partners, and supply chain members acting only in their own interest.
- Collaborative: Supply chain members plan and execute supply chain operations collaboratively.
- Ongoing partnership: Long-term collaboration between supply chain members based on mutual trust.

Ongoing partnerships lack a decisive impact on sustainable practices in this study. This condition exacerbates the fact that most of the literature only emphasizes the positive aspects of long-term relationships (Mitreğa et al., 2012).

- It is possible that many firms are stuck in business relationships that are long-term and trusting without any confirmation of their added economic value.
- Exit barriers (changing suppliers would entail high costs, a limited number of suppliers, etc.)
- The lack of effort of supply chain partners throughout the course of the relationship.

#### 4.4 New scientific results

The study showed that the product variety–supply chain relationship must be considered in a more differentiated way by:

- analyzing performance-relevant indicators like on-time delivery or customer complaints
- considering different levels of product variety increases
- focusing on different industries

On the one hand, this study discovers that there are industry differences (e.g., slow and fast fashion firms) concerning the impact of an increase in product variety on supply chain performance. Different industries perceive the increase in product variety's impact on performance differently. This study also suggests that fast fashion firms rated their performance (e.g., ability to respond to new market trends or ability to reduce the complexity of the supply chain) better on average than slow fashion firms or firms from other sectors compared to the competition.

On the other hand, this study discovers that most performance-related indicators develop favorably for the supply chain with increasing product variety. For example, the majority of those surveyed stated that the efficiency of the material or information flow increases with increasing product variety. This finding shows that many supply chains are flexible and know how to deal with the requirements of greater product variety.

The study also concludes that the complexity of supply chains matters concerning the performance-related indicators of efficiency in the flow of materials, reliability of supply chain actors, risk of stock-out, customer complaints, and product quality. More complex supply chains have a different way of dealing with the variety of products concerning these indicators than less complex supply chains. The philosophy underlying this idea is that these companies may have already found a way to deal with complexity.

This study identifies that a 5–10% increase in product variety does not affect slow and fast fashion supply chains' qualitative or financial performance differently in the short or medium run. However, a 1–4% increase affects such an area differently within both 1-year and 3-year time frames. Thus, this study concludes that a more significant increase in product variety may stimulate better adjustments in supply chains, enabling them to be traded.

Table 29 gives an overview of new scientific results that this study offers:

*Table 29: Overview of new scientific insights*

Investigation	Key finding
Type of industry ↔ product variety's impact on performance	Different industries perceive the increase in product variety's impact on performance differently.
Type of industry ↔ performance rating	Fast fashion firms rate their performance better on average than slow fashion firms.
Product variety ↔ performance-relevant indicators	Most performance-related indicators develop favorably for the supply chain with increasing

	product variety.
More (less) complex supply chains ↔ performance-relevant indicators	More complex supply chains have a different way of dealing with product varieties than less complex supply chains.
1–4% increase in product variety ↔ supply chains' qualitative or financial performance	A 1–4% increase in product variety does affect slow and fast fashion supply chains' qualitative or financial performance differently.
Performance measure ↔ success of supply chain management	There is a significant relationship between performance measure used and success of supply chain management.
Product variety ↔ supply chain integration	There is a significant relationship between product variety and supply chain integration (measured over the type of relationship with supply chain members, e.g. collaborative or ongoing partnership).
Supply chain sustainability ↔ ability to increase product diversity without sacrificing performance	There is a significant relationship between supply chain sustainability and the ability to increase product diversity without sacrificing performance.
Supply chain sustainability ↔ Supply chain integration	There is a significant relationship between supply chain sustainability and supply chain integration (measured over the type of relationship with supply chain members, e.g., collaborative, or ongoing partnership).

Source: Author's table

#### 4.5 Limitations and future research directions

This study has several limitations that researchers should address in future studies. One of those limitations is regarding the data collection and analysis. The data collection activity involved international supply chain practitioners who currently have or previously had a role in supply chain management, regardless of their country of origin. So, the survey excluded a comparison between countries. Such exclusion was due to the restriction for the questionnaire to exceed a certain length otherwise it may discourage participants. The exclusion also applied to sensitive questions, such as the question about gender, due to their potential to trigger frustration and uncertainty among respondents, risking their response rates (Hughes et al., 2016).

Another limitation of the study is regarding product variety. Although this study sometimes utilizes product variety and product complexity synonymously, it does not utilize product complexity as per the definition by Bortolotti et al. (2013) and Caniato & Größler (2015), which is the level of complexity of the products manufactured at the firm.

Instead, the definition of product variety follows the definition of Berry & Cooper (1999), which is the number of products produced.

All collected data was in German and English, as the literature search only involved keywords in these two languages, resulting in only English and German abstracts and titles. The literature search exclude resources from ABI/INFORM Global, Google Scholar, and Elsevier databases.

The fluctuating level of respondents' willingness to participate led to the overrepresentation and underrepresentation of certain industries, like the construction industry which was better represented than other industries, in this study.

Although the author has provided explanations of terms used in this research, a small risk of misinterpretation remains. For instance, people may have diverse comprehension of the term supply chain management due to the absence of uniformity in its usage.

Moreover, it would be hard to determine the right classification for different sectors included in this study. For instance, respondents from different sectors may have different perspectives and thus provide different responses to the same question. The employment of the Likert scale in many questions also proved to be a challenge in itself. It was not that easy to determine what each value of the scale means due to the diversity of question types and contexts.

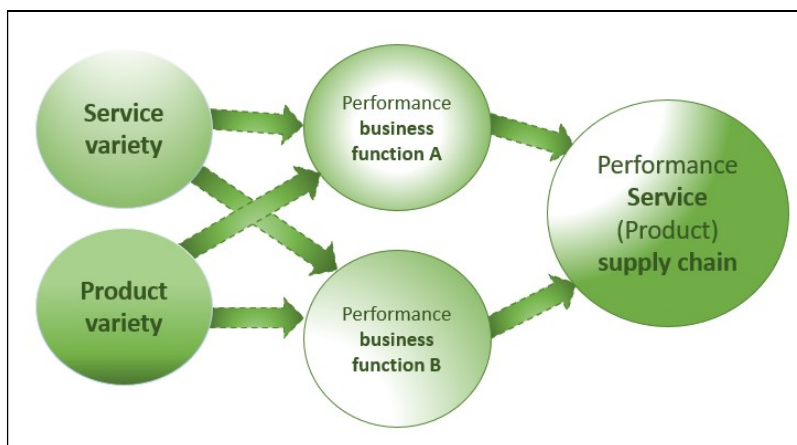
The current study focuses on investigating supply chain systems in different sectors. The service sector, which focuses on the interactions between customers and service providers instead of physical products, shall receive more attention in the future since it is the most significant contributor to global revenue. The idea that serviced products also occur in manufacturing industries and that pure service supply chains may be hard to find makes the topic more intriguing (Thakur et al., 2016). Thus, it might be the time to start studying service variety rather than merely focusing on product variety.

Although the author has not made enough involvement and contributions to the field, it is clear that the scientific community has not explored the topics of service supply chain and service variety well enough. Thus, this study serves as a precursor for future studies as

it offers the foundation for understanding supply chain performance which researchers may use to explore the service variety topic. One of this study's most central questions in this context is whether service supply chains behave differently in terms of service variety and performance than "product supply chains" and the mixed form "product service supply chains".

Paying attention to different business functions would enable researchers to create more detailed questions regarding service variety's impact on supply chain performance. In this regard, this study plans to investigate the impact of the service variety increase on various business functions, including manufacturing, engineering, purchasing, logistics, and marketing (Krishnan et al., 2001). Such investigation shall involve an understanding of the preferences of individuals involved in the supply chain system since they may have distinct and conflicting objectives concerning service (product) variety (e.g. production managers reject high product diversity and prefer low process complexity, while marketing managers try to satisfy the most diverse customer needs and actively promote greater product diversity) (Kekre and Srinivasan, 1990). In addition, it is also necessary to understand the costs and drivers of complexity since this study may focus on one area, allowing the study to avoid engaging in low-value activities that could have serious consequences (Child et al., 1990).

A rough visualization of how the author plans future work is shown in figure 21.



**Figure 21: Key ideas for future work**  
Source: Author's figure

The author believes that it is important to constantly develop knowledge and assumptions. Thus, future studies may also include the feedback of this study's respondents

(small note: the feedback arrived at the end of the questionnaire phase and therefore could not be considered when creating the questionnaire). This study should present this feedback to the readers, with the most constructive ones as follow:

- One respondent was an outlier. She saw little or no impact of the complexity of the range or product variety changes on the performance of a professional supply chain organization.

*“I’ve added my contribution to the survey. I’d add one more aspect as there were no free text fields included in the survey: The importance of context is really critical here. All the supply chains I work with expect zero or little to none change in financial (hard KPIs) and soft/qualitative performance when changing complexity via assortment or product portfolio changes (even if that goes up to 10% change). Hence the answers. We make a huge effort to run a supply chain organisation that can deal with these in a professional manner, so that part is a huge contributor to the successes.”*

- The subsequent respondent suggested that the study should consider the competence of staff involved in the supply chain system.

*“I have a suggestion for your consideration. Maybe you can also look at the impact of supply chain personnel competency and it’s affect on product variety, which requires aggressive product and vendor development. Most supply chain professionals take a narrow vision preferring to stay with existing vendor/product pool, i.e., have a more tactical approach to sourcing. Needless to state this compromises the organizations’ ability to increase its product offering downstream.”*

*Another respondent pointed out that the focus of the questionnaire was limited because, in his opinion, it only referred to the production aspect.*

*“I wish I could help but I don’t think my background is the ideal fit for your research, as I came from deep-sea shipping. I think that the thrust for your questions is aimed towards the production side of industry.”*

- Four respondents highlighted that people who merely help and guide others regarding supply chain operations or people with no physical supply chain operation shall not participate in the survey.

*“I would be happy to participate in the survey; however, upon review it appears it is intended more for someone in an organization with a physical supply chain, whereas I provide guidance to several such companies.”*

*“I’ve been looking at your (very interesting!) survey, but as I am in a training and consulting role, I’m afraid that my answers don’t make a lot of sense. Even though also ‘service’ companies do have something that you could call a supply chain, it still isn’t really worthwhile to answer all the questions: too many of them are rather triggering my ‘imagination’ (what-if or examples from customers in the past) instead of allowing me to give my own insights on the initial question: how do supply chain performance and product variety relate to each other.”*

*“Thanks for reaching out. I reviewed the survey. Since I am a consultant it was not possible to answer your questions from a singular company perspective because I work with a variety of firms.”*

*“Our firm is a consulting firm, so when I look at the questions I don’t think, this is much applicable.”*

*“Sorry, I haven’t a Supply Chain in my company; we develop a cloud platform for end to end visibility and collaboration for Supply Chain; so I think I’m not your right target to answer.”*

- One respondent also said that the questions in the questionnaire should have been simpler so they could better imagine the scenarios.

*“Managed to answer the questionnaire. It took me about 7 minutes. I think a few too many factors are crammed into single questions, that respondents may find it hard to conceptualize the scenarios. I wonder if you’ve done an interview format with guided illustrations.”*



## 5. SUMMARY

This dissertation aims to investigate the product variety increase–supply chain performance relationship. This topic of discussion has sparked debates among researchers as they have yet to agree on the impact of increasing product varieties on a firm's supply chain performance. The supply chain performance variable encompasses variable components from customer satisfaction to logistic costs. This study reviewed the literature on product variety, supply chain management, and the fast-fashion industry. Fast-fashion firms were selected because they offer unique characteristics and dimensions due to their short lead times and life cycles. The study confirmed prevailing assumptions and provided new insights resulting from the analysis of the responses of 285 supply chain practitioners.

The author offered the perspectives of diverse supply chain practitioners who come from various countries, allowing the study to benchmark the supply chain performance of various international firms. Moreover, this study's empirical findings help close the gap in the area of research. Its research goals are: to determine the impacts of product variety increase on the supply chain's qualitative and financial performance and to determine if supply chain practitioners prioritize the success of their systems.

This study's results indicate that many supply chain practitioners regard product variety as an essential driver of supply chain complexities, suggesting that they were aware of its negative impacts on supply chain performance. The study further discovered that the product variety increase affects certain supply chain areas, such as the flow of information and materials. It further found that the relationship between supply chain members influences the success of supply chain systems, as positive collaborations foster better supply chain performance regardless of the level of product variety it manages.

Overall, respondents were aware of the risks of product variety on supply chain management. This study's hypothesis testing procedure further confirmed the existence of the product variety increase–supply chain performance relationship both in the short term (1-year-time-frame) and medium term (3-year-time-frame) with different impacts for fast-fashion and slow-fashion firms. c The final finding would be that product variety influences both supply chain complexity and supply chain performance. Thus, supply chain executives shall address product variety issues and carefully determine the most appropriate product variety level for their firms.

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## APPENDICES

### SURVEY QUESTIONNAIRE English

Dear participant!

This survey examines the impact of product variety on the Supply Chain Performance. Your participation is critical to the success of the study. Your answers will be kept confidential and used for scientific research purposes only. Please try to answer the questions from your own firm's supply chain perspective.

The questionnaire takes about 5 minutes to complete.

Two vouchers worth each EUR 50.00 will be raffled among all participants. You can find more information about the competition on the last page of the questionnaire.

Yours sincerely

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**QUESTION 1: In which of the following sectors is your company active?** Please indicate the main economic sector in which the highest turnover is achieved.

- Construction
- Chemicals/Plastics
- Print/Paper
- Retail
- Electrical/Electronics
- Health and social services
- Wholesale
- Production and processing of glass, production of goods from stones and Earth
- Wood/Furniture
- Information and communication
- Motor vehicle
- Agriculture and forestry
- Metal/mechanical engineering
- Food/luxury foods (manufacturing of food and luxury foods and beverages)
- Personal Services
- Textile/Clothing/Leather
- Tourism (accommodation and catering)
- Traffic
- Business Services
- Other industries

**QUESTION 1.1: If you work in the fashion/textile industry, what applies best?**

- Slow Fashion
- Fast Fashion

**QUESTION 2: What is your firm's role in the supply chain?** Multiple answers possible.

- Member, representative or organizer of a supply chain manager association
- Scientific activity/research in the field of supply chain management
- Teaching activities in the field of supply chain management
- Currently in supply chain management training
- Completed training in supply chain management
- Supply chain function with management function (current or in the past)
- Supply chain function without management function (current or in the past)
- Other

**QUESTION 3: How much do you agree or disagree with the following statements.**

1 = strongly disagree, 2 = disagree, 3 = Neither Agree nor Disagree, 4 = agree, 5 = strongly agree (see table below)

	1 Strongly disagree	2	3	4	5 Strongly agree
My firm's supply chain is complex.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My firm can modify its product features quickly to meet customer requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
We undertake a joint planning (e.g. when a product variety increase takes place) with other supply chain members. How much do you agree or disagree with the statement: "There is a need for joint planning."	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The firm can quickly introduce new products in the market.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The supply chain can deliver value-added after-sales services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**QUESTION 4: Which performance measure is used in your firm's supply chain?**

Examples for qualitative performance indicators are customer satisfaction and quality. Examples for quantitative key performance indicators are throughput time, response time in the supply chain, resource utilization.

- The firm's supply chain performance is measured in qualitative terms.
- The firm's supply chain performance is measured in quantitative terms.
- The firm's supply chain performance is measured in qualitative as well as quantitative terms.
- The firm's supply chain performance is not measured at all.

**QUESTION 5: Why does your firm operate in a (global) supply chain? Please choose the most important reason.**

- Increase in customer satisfaction
- Increase in profits
- Improving the focus on core competencies
- Improving market share
- Improving productivity
- Reduction of inventory
- Reduction of costs

**QUESTION 6: How successful is your firm in managing its supply chain?**

- Very successful
- Successful
- Somewhat successful
- Not successful
- Not successful at all

**QUESTION 7: What is, in your opinion, the impact of increasing product variety on the following aspects of supply chain management (see table below).**

	increases	no effect	decreases
7.1 Efficiency in flow of information in the supply chain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.2 Efficiency in flow of materials in the whole supply chain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.3 The reliability of the supply chain actors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.4 The delivery of zero-defect products	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.5 The ability to rapidly improve responsiveness to changing market needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.6 Response time (time between when a customer places an order and receives delivery).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.7 Risk of Stock-out	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.8 Ability to change the quantity of orders to suppliers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.9 On-time delivery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.10 Customer complaints	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.11 Product quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**QUESTION 8: Which companies in the Supply Chain does the firm maintain relationships with? Please select the answer that fits best.**

- With upstream stage of the supply chain
- With downstream stage of the supply chain
- With all stages of the supply chain
- Neither nor
- Other

**QUESTION 9: How would you characterize your firm's interactions with suppliers/and or customers?**

Transactional = This type of collaboration focuses on demand and supply between supply chain partners, the supply chain members acting only in their own interest.  
Collaborative = Supply chain members plan and execute supply chain operations together. Ongoing partnership = Long-term collaboration between supply chain members based on trust.

- Transactional
- Collaborative
- On-going partnership
- Other



**QUESTION 10: The following questions are about how your firm's supply chain has been performing in comparison to other firms in the industry. In general, kindly indicate the performance level of your firm's supply chain.**

**1 = extremely worse, 5 = extremely better**

	<b>1</b> extremely worse	<b>2</b>	<b>3</b>	<b>3</b>	<b>5</b> extremely better
Ability to respond to and accommodate demand variations, such as seasonality.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to reduce the total cost of resources used.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to increase product variety without decreasing supply chain performance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to respond to new market trends.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to easily reduce the supply chain's complexity.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to improve the sustainability of the supply chain.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to improve product variety management in the supply chain.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to increase product variety without decreasing performance in terms of replenishment lead time and cost.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**QUESTION 11: What is the most important reason for the high level of complexity in your firm's supply chain?** Please choose one of the following answers.

- Number of products offered / product variety offered
- The high number of supply chain players
- Decision making process
- Lack of control over processes
- Forecasting issues
- Information deficits/information problems
- Internationalization
- Shorter product life cycles
- Changed customer expectations (needs)

**QUESTION 12: Now please imagine that the company INCREASES THE VARIETY OF OFFERS by 1 to 4%. What will be the IMPACT on the different areas listed below? The rating is from 1=No Impact, 2=Minor, 3=Moderate, 4=Medium, 5=High Impact**

Financial performance: means "hard" factors such as lead time; Qualitative performance means "soft" factors such as customer satisfaction.

**If my firm increases the variety of products on offer by 1 to 4 %..**

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
	No impact				High impact
..the degree of an expected change in <u>financial performance</u> within a 1-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the degree of an expected change in <u>financial performance</u> within a 3-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the degree of an expected change in <u>qualitative performance</u> within a 1-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the degree of an expected change in <u>qualitative performance</u> within a 3-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the impact on the firm's supply chain will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**QUESTION 13: If my firm increases the variety of products on offer by 5 to 10 %..**

	<b>1</b> No impact	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b> High impact
..the degree of an expected change in <u>financial performance</u> within a 1-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the degree of an expected change in <u>financial performance</u> within a 3-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the degree of an expected change in <u>qualitative performance</u> within a 1-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the degree of an expected change in <u>qualitative performance</u> within a 3-year time frame will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
..the impact on the firm's supply chain will be ..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

-- THANK YOU FOR YOUR PARTICIPATION --

If you are interested in the results of the survey, please enter your email address.

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If you would like to be entered into the prize draw, please enter your email address here. Two vouchers worth EUR 50.00 each, which can be redeemed online at over 100 shops, will be raffled off among all participants. Details on the vouchers can be found here <https://shop.wunschgutschein.at/>

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## ACKNOWLEDGEMENTS

First, I would like to thank my doctoral supervisor, Prof. Dr. Dr. h.c. Csaba Székely DSc, for the outstanding collaboration and the many valuable inputs. Working together with him was enjoyable and brought lots of new insights.

A very special thanks also goes to Univ.-Prof. Dr. Dr. h. c. Irena Zavrl, Ph.D., a kind soul always available for exchange, and of course, Prof. Dr. Csilla Obádovics, Ph.D., who was an asset in every respect with her knowledge and expertise.

Thank you to my mother and sister for being invaluable confidantes and supporters throughout my life. It only remains for me to say that I hope, in the future, I can do something for you in return.

I would also like to thank Muhammad and Rifki, who contacted further potential questionnaire participants using predetermined criteria and proofread the work.

Without seeming conceited, I would also like to thank myself because, in the end, I was the one who completed this dissertation and was willing to develop and grow spiritually.

**Declaration**

I, the undersigned Christina Schabasser, by signing this declaration declare that my PhD thesis “Strategic analysis of product variety and supply chain complexity in the fast fashion apparel industry” was my own work; during the dissertation I complied with the LXXVI and the rules of the doctoral dissertation prescribed by the Doctoral School, especially regarding references and citations.<sup>1</sup>

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