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Analysis of the Association between Receivements from Suppliers, Shipments to Clients and Perception of External Supply Chain Risks: a comparison between Portugal and Norway

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Master in Management of Services and Technology

Supervisor:
PhD Ana Lúcia Henriques Martins, Assistant Professor, Iscte Business School

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BUSINESS
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Department of Marketing, Operations and General Management

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Abstract

The study of Supply Chain Management has been recently gaining interest in academia literature (Ayaviri & Saucedo, 2017). Organisations face an ever more elaborate environment, that is continuously shifting, rising supply chain risks, thus making companies vulnerable to disruptions in the supply chain (Munir et al., 2020).

The goal of this dissertation is to understand the association between the perception of external risk factors in the supply chain, delays in deliveries and delays in the reception of materials from suppliers.

The data used in this research originated from a scientific database providing evidence from 145 transforming companies of multiple industry sectors, based in two countries: Portugal and Norway. A quantitative study was conducted, resorting to the statistical analysis software tool IBM SPSS Statistics (version 27).

The findings of this study suggest that the external risk in the supply chain is perceived differently in Portugal and Norway, under the scope of the sample used. Overall, the correlation coefficients measured for firms in Norway are relatively lower than those regarding Portuguese firms - the companies present in Portugal have demonstrated a higher propensity to perceive external micro risks. In both nations, there were no significant variations in the analysis of the link between delays in receivements and delays in shipments, and the results suggested no significant correlation among the two; this may indicate that the firms in the scope of the sample used have common perceptions of their capabilities to overcome potential upstream delays and avoid causing delays in shipments to their clients.

Keywords: Supply Chain; Supply Chain Management; External Risk; Supplier Delays; Client Delays.

JEL Classification System: M110 (Business Administration: Production Management) ; Y40 (Dissertation)

Resumo

O estudo da Gestão da Cadeia de Abastecimento tem, recentemente, despertado grande interesse na literatura académica (Ayaviri e Saucedo, 2017). As empresas enfrentam um meio envolvente que continuamente sofre transformações, incrementando os riscos da cadeia de abastecimento, traduzindo-se numa maior vulnerabilidade às disrupções. (Munir et al., 2020).

O objetivo desta dissertação é estudar a associação entre a perceção de fatores de risco externos na cadeia de abastecimento, atrasos nas entregas a clientes e atrasos na receção de matérias de fornecedores.

Os dados utilizados nesta pesquisa tiveram origem numa base de dados científica, contendo informação sobre 145 empresas de variados setores, presentes em dois países: Portugal e Noruega. Foi conduzido um estudo quantitativo, recorrendo ao software de análise estatística IBM SPSS Statistics (versão 27).

Os resultados deste estudo sugerem diferenças entre países na perceção do risco externo na cadeia de abastecimento, no âmbito da amostra considerada. No geral, os coeficientes de correlação calculados para as empresas Norueguesas são relativamente inferiores do que aqueles relacionados com empresas Portuguesas – as firmas em Portugal demonstraram uma maior propensão na perceção de micro riscos externos. Em ambos os países, não foi verificada uma variação significativa na análise da correlação entre atrasos nos recebimentos e atrasos nos envios, sugerindo a não existência de uma relação significativa entre ambos; este facto poderá indicar que as empresas que constituem a amostra têm uma perceção semelhante nas suas capacidades para ultrapassar potenciais atrasos a montante e evitar que estes se relacionem com atrasos em envios para os seus clientes.

Palavras-chave: Cadeia de Abastecimento; Gestão da Cadeia de Abastecimento; Risco Externo; Atrasos de Fornecedores; Atrasos para Clientes.

Sistema de Classificação JEL: M110 (Business Administration: Production Management) ; Y40 (Dissertation)

Index

List of Figures

List of Tables

Glossary

CSCMP – Council of Supply Chain Management Professionals

SC – Supply Chain

SCM – Supply Chain Management

CHAPTER 1

Introduction

In this first chapter, the theme and context of this thesis are going to be presented, as well as its relevance and the problem statement. Subsequently, the main and partial objectives will be revealed, as well as the research questions. Following, the methodology and the scope of research will be identified, and the structure of the dissertation will be displayed.

1.1 Context

According to Varzandeh et. al. (2016:1), "supply chains are the backbone of the global economy, fuelling trade, consumption, and economic growth.". Consequently, as stated by the same authors, the increase in risk and the growing uncertainties in the global economy, originated by the disparity in volume between supply and demand, represent major concerns for companies to tackle.

It is possible to observe an ever growing concern in the research of themes related with supply chain, through the increase of scientific publications over the years (Ayaviri & Saucedo, 2017).

Christopher (2016) refers that there has been an increase in the vulnerability of the supply chain to disturbance or disruption – the impacts of internal changes (the shifts in the business models of the organisations, such as the adoption of lean practices, the trend to outsourcing or the reduction of the supplier base) and the external environment (external events, for instance natural disasters, terrorism, unstable political circumstances, strikes, transport issues, restrictions on imports/exports) contribute to a greater risk in the supply chain.

Given this constant changing elaborated environment where organisations operate, alongside with the operational strategies adopted by them, a higher level of vulnerability and risks arise in the supply chain, making organisations susceptible to unexpected disruptions (Munir et al., 2020). For instance, as specified by Haraguchi and Lall (2014), the floods in Thailand, in 2011, struck the automotive industry - Toyota Motor Corporation and Nissan Motor Company were compelled to stop all operations, as they suffered from a great lack of parts from their suppliers. This resulted in a financial loss of USD 1.25 billion for Toyota and USD 70 million for Nissan (Haraguchi & Lall, 2014). Therefore, given the rising complexity and interrelation of modern supply chains, the outcome of any actions or events have become quite difficult to anticipate (Helbing et al., 2006).

Ho et al. (2015) identified various opportunities and gaps in literature regarding supply chain risk. One of them is the research gap of infrastructural risk, that contemplates transportation, information, financial risk and macro risks; another gap is the lack of studies in service supply chain, due to the fact that many researchers focused solely on manufacturing supply chains. The risk monitoring process was also referred, raising awareness to the need to develop early warning monitoring systems for multiple types of supply chains. Analysing the costs and benefits of the management of the risk in the supply chain was also claimed by the same authors as a research gap, suggesting to other researchers a multiple case study approach to access benefits and losses between companies that adopt Supply Chain Risk Management and the ones that do not follow this method. It is also suggested by the same authors that, despite the fact that focusing on one particular risk type presents clear benefits, the examination of the joint impact of all types of risk may lead to a better management of supply chains.

At the current juncture, the recent coronavirus (COVID-19/SARS-CoV-2) outbreak constitutes one of the uppermost disruptions of the last decades, causing the collapse of many global supply chains (Araz et al., 2020). As mentioned by Ivanov (2020), this epidemic outbreak creates much uncertainty, being characterized by long-term disruption and unpredictable scaling, and disturbances in supply, demand and logistics infrastructure. The current pandemic shows that there is an urgency in developing new business strategies in the design of future supply chain – because of the globalization of supply chains, the damaging effects of disruptions present a broader impact (Ojala, 2020).

According to Heckmann et al. (2015:119), "every process and decision in business is prone to uncertainty.". The increasing complexity of supply chains has made it highly difficult – or even impossible - to forecast the consequences of unexpected events. (Heckmann et al., 2015).

Proactively managing the supply-chain risk is extremely important – "potential supply chain risks include delays, disruptions, forecast inaccuracies, terrorism, systems breakdowns, inventory problems and capacity issues" (Chopra & Sodi, 2004:53); the way a firm deals against these menaces is determined by the type of disruption and the level of preparation for such events (Chopra & Sodi, 2004).

According to Harland et al. (2003), the attitude towards risk varies not merely by the firm's business and its nature, but additionally by "individual style and behaviour" (Harland et al., 2003: 54), meaning that the attitude when experiencing risk takes into account not only the nature of the business, but also the changes in behaviour, that can be heavily influenced by experience: if a firm or sector is usually a risk-taker and experiences a major decline in the business, the attitude towards risk may drastically change (Harland et al., 2003).

Chopra and Sodi (2004:55) state that "delays in material flows often occur when a supplier, through high utilization or another cause of inflexibility, cannot respond to changes in demand", categorizing delays as a crucial risk in the supply chain.

Supply chain risks can be extremely harmful and result in significant delays in costumer deliveries (Wu et al., 2006), making many industrial firms put efforts in order to optimize their manufacturing supply system, in such a manner to produce and deliver in time (Turki & Rezg, 2017), avoiding delays in shipments from the firm to its clients.

Prior research states that national culture explains differences in supply management and propensity to seek risk (Weber et al., 1998). Wagner and Bode (2008) conducted a study on how the effects of supply chain risk occurrence and how supply risk is perceived and managed, and the findings indicate that some differences in risk perception and management exist between the USA and Germany. Nonetheless, studies regarding the comparison of risk between Portugal and other countries were not found.

Given the fact that supply chain risk's perception may differ between countries, it is relevant to compare and assess differences and similarities among different countries. Norway and Portugal are both European pheripheral countries; however, typical weather in Portugal is maritime temperate (cool and rain presence in north, warmer and drier in south) and in Norway, it is modified by North Atlantic Current, having a heavy presence of rain throughout the year (colder interior with increased precipitation and colder summers) (NationMaster, 2020). This difference in weather impacts transport networks, and may cause large disruptions in the supply chain (Rietveld, 2013).

Although relevant and up to date, there is some lack of studies regarding this topic. This thesis is an attempt to fill this gap and to contribute to the knowledge in this area.

1.2 Objectives

This research aims to conduct a comparative analysis of the perception of risk from external factors and the link between delays in receivements from suppliers and delays in shipments to clients, between Portugal and Norway.

Provided this, the particular objectives of this dissertation are:

i - Determine if there is an association between delays in receivements from suppliers and the way external risk factors are perceived;

ii - Determine if there is an association between delays in shipments to clients and the way external risk factors are perceived;

iii – Determine if there is an association between delays in receivements from suppliers and delays in shipments to clients.

1.3 Research Questions

Taking into account the context and the objectives of this dissertation, the general research question for this work is:

- To what extent does the perception of risk in the supply chain influence the firm's ability to absorb fluctuations in receivements from suppliers and not translate them into losses of quality towards the service provided to their customers?

The particular research questions are defined as followed:

- RQ1: Is the risk from external factors associated with delays in receivements from suppliers?
- RQ2: Is the risk from external factors associated with delays in shipments to clients?
- RQ3: Are the delays in receivements from suppliers associated with delays in shipments to clients?

1.4 Methodology

The scarcity of research in the Supply Chain Management field translates into an opportunity for further investigation and development, as seen in the Context section. In order to attain the objectives of this research and answer to the research questions, a pre-existent scientific database was used. This scientific database resorts to a questionnaire submitted to different firms present in Portugal and Norway. From this database, a specific set of variables were selected, and data was later transformed.

Hence, this will be a quantitative research based on data present in a scientific database, examined using the advanced statistical analysis software platform IBM SPSS Statistics (version 27).

1.5 Scope

The scope of application of this study will be 145 transforming companies of various industry sectors from two countries: Portugal and Norway (92 Norwegian companies, and 43 Portuguese companies). Perception of external risk, delays in deliveries and delays in the reception of materials are the focus of the research.

1.6 Dissertation Structure

This thesis consists of six chapters. This first chapter includes an introduction and the context of the theme of this research, as well as the objectives, research questions, and the scope of the research.

In the second chapter, the Literature Review will be conducted. The concepts of supply chain and supply chain management will be addressed, in conjunction with the different types of risks in the supply chain. The delays in receivements from suppliers and the delays in shipments to clients will also be undertaken in this chapter, as well as related work in this field.

The methodology of this thesis will be described in the third chapter – the research design, focus of study and the population and sample size will be thoroughly explained.

In the fourth chapter, the variables will be built and the answers of the survey will be characterized and the correlations conduced. The discussion of the results will be carried out in the fifth chapter and the conclusions of this thesis will be drawn in the sixth chapter.

CHAPTER 2

Literature Review

2.1 Introduction

This section aims to address the main topics and concepts present in this thesis, as for sustaining a solid theoretical foundation for the research's development, through the analysis of the central topics – the concept of supply chain and supply chain management, the notion of risk in the supply chain and the sources and types of risks that exist in the supply chain, external risk factors and its perception, delays in receivements from suppliers, delays in shipments to clients and a brief analysis of related work conducted in this field.

2.2 Supply Chain and Supply Chain Management

2.2.1 Supply Chain

The term of supply chain (SC) was first used in the early 1980's, as a reaction to modifications in the trends in business strategies – increasing efficiency in the organisation and adding value to the customer and shareholders was crucial, leading to a redefinition of the business activities, in particular for "logistics" and manufacturing-based "operations management" (Christopher & Peck, 2004:2).

In the 1990's, considered the efficiency driven age of "business process reengineering", the elements of logistics, operation management and marketing were added into the management of the SC (Christopher & Peck, 2004:2). According to the same authors, because of the globalisation and the consequent increase in the SCs length, the number of links and nodes increased and new types of disruptions arose, such as terrorism and natural disasters, and this concept was starting to be used in other areas, such as politics and the wider public, instead of being confined to academia and specialist sectors of the industry.

As maintained by Lummus and Vokurka (1999), firms realized that there were benefits in collaborative relationships, both within and beyond the organisation, since they could not effectively compete isolated from their suppliers and the other institutions present in their SC. This, in its turn, caused an interest in the management of the supply chain.

In 1994, La Londe and Masters suggested a definition of supply chain as a set of firms that move materials forward, composed by several independent firms that are responsible for the manufacturing and placing of the product at the end user - raw material, component producers, product assemblers, wholesalers, retailers and transportation companies.

The definition of supply chain by Quinn (1997:43) includes not only all of the activities related with the flow of goods, from the raw materials stage to the end user, as well as "sourcing, procurement, production scheduling order processing, inventory management, transportation, warehousing, and customer service" and furthermore, all of the information systems that are needed to support all these activities. The inclusion of the information systems and the technology associated was subjected to a high-speed development that lead to further enhancements in efficiency and exponential awareness of emerging customer requirements and a dynamic marketplace (Christopher & Peck, 2004).

Lummus and Vokurka (1999:11) defined supply chain as "all the activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer, and the information systems necessary to monitor all of these activities".

Mentzer et al. (2001:4) describe supply chain as a "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.". In this definition, the final consumer is also a member of the supply chain.

The definition of supply chain provided by Christopher & Peck (2004) encompasses the network of organisations responsible for all the different processes and activities that produce value as products and services for the final consumers, through upstream and downstream linkages. These authors adopted and end-to-end perspective of product and information flows from the source of raw materials to the end costumer, and even further – after-sales and returns are also to be considered in the SC (Christopher & Peck, 2004).

The Council of Supply Chain Management Professionals (CSCMP, 2020:186) currently defines the supply chain as "1) starting with unprocessed raw materials and ending with the final customer using the finished goods, the supply chain links many companies together; 2) the material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end user. All vendors, service providers and customers are links in the supply chain.". This definition considers all the activities and organisations that partake in the process of all the production and delivery of a product to the end consumer, in a global way.

Supply chains evolve and transform in size, shape and configuration, and in the way they are managed (MacCarthy et al., 2016); modern firms are inserted in a fast-changing, complex, environment (Wiengarten et al., 2016) and progressively depend on complex networks of

suppliers in order to deliver goods and services at the appropriate time, place and quantity required (Munir et al., 2020).

After the careful analysis on the concept of supply chain, it is noticed that it has been the subject of research throughout the years. In this dissertation, the definition of SC used will be the most recent one, provided by the CSCMP (2020).

2.2.2 Supply Chain Management

Throughout the last 20 years, the scope and the definition of Supply Chain Management (SCM) has been developing – its definition is continuing to evolve, and the scope has become broader (Parki, 2015). Particularly since the 1980's, the adoption of SCM practices by organisations has been rising (Shukla et al., 2011). Mentzer et al. (2001) refer that certain motives for this prevalence are the globalization of the supply chains and faster and damage-free deliveries demands from costumers, since delivering a product without defects and faster than the competition is no longer seen as a competitive advantage, but as a market requirement. The uncertainty caused by these demands, associated with global SCs, fast-changing technology and economic factors, demand more flexibility in managing the SC relationships (Mentzer et al., 2001).

In 1993, Ellram and Cooper defined SCM as planning and controlling the flow of materials, from suppliers to the end consumer, applying an integrated management approach to this concept. Mentzer (1993:31) suggested that SCM is concerned with the flows of materials and information, having the purpose of the "synchronization of all channel activities in a manner which will create the greatest net comparative value for the customer.".

Other authors define SCM considering a management philosophy: Cooper (1994:46) stated that SCM is associated with "all the steps of a product's movement, regardless of corporate, political, or geographical boundaries, from raw material supply through final delivery to ultimate user to satisfy a particular customer group", whereas La Londe (1996:15) explains SCM "as the delivery of enhanced customer and economic value through synchronized management of the flow of physical goods and associated information from sourcing through consumption."

The Global Supply Chain Forum defines supply chain management as "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders" (Lambert et al. 1998:1).

Mentzer et al. (2001:19) defines SCM as “the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole”, having in mind all business functions (such as Marketing, Sales, Production, Logistics, among others) and all the SC flows for planning, organising and processes, stating that having an inter-functional coordination allows for the reach of the SC full potential, achieving the ultimate goals of SCM – “lower costs, increased customer value and satisfaction, and ultimately competitive advantage” (Mentzer et al., 2001:19).

Johnston et al. (2012:154) denominated SCM as being “concerned with managing the network and the flow of information, materials, services and customers through the network”.

Ross (2013:9) states that SCM is a “continuously evolving management philosophy that seeks to unify the collective productive competencies and resources of the business functions found both within the enterprise and outside in the firm's allied business partners located along intersecting supply channels into a highly competitive, customer-enriching supply system focused on developing innovative solutions and synchronizing the flow of marketplace products, services, and information to create unique, individualized sources of customer value”.

Christopher (2016) considers that SCM encompasses the upstream and downstream relationships with both suppliers and customers, having the purpose to deliver value at lower costs for the entire SC.

The CSCMP (2020:187) defined that “Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies. Supply Chain Management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology."

Considering the SCM’s definitions provided previously, it is possible to disclose that this topic has been the subject of numerous research throughout the years, evolving and adapting to the changes in the market. Ellram and Cooper (1993) consider SCM as a flow of materials,

while Mentzer (1993) adds the information flow to the definition, and Lalonde (1996) also includes economic value in the term. The Global Supply Chain Forum (Lambert et al., 1998) and Lummus and Vokuka (1999) refer the managing of business processes, the later highlighting the difference between SCM and logistics management. Christopher (2016) considered the upstream and downstream relationships, whereas Johnston et al. (2012) and the CSCMP considered all the processes and the entire network.

2.3 The Concept of Risk in the Supply Chain

A supply chain disruption is any unexpected phenomenon that can halt the flow of goods and services and provoke effects on costs (financial, operational and relational) (Sodhi et al., 2012; Wagner & Bode, 2008). The frequency and the severity of these disruptions have been rising; consequently, companies have been concentrating on better understanding and managing the supply chain risk (Chopra & Sodhi, 2014).

Alongside the increase of competition among firms and the improvement of the complexity of supply chain, the uprising of supply chain risk has carried a great impact on firms (Huo et al., 2019). In the SCM field, in particular, the meaning of risk is not clear (Heckmann et al., 2015). The Risk Response Network of the World Economic Forum (2013) has pinpointed that the creation of a common definition and a clear understanding of supply chain risk is of the outmost importance.

Christopher and Peck (2004) stated that the definition of risk carries many different interpretations in the academia literature. The same authors define risk using the definition provided by March and Shapira (1987:1404) corresponding to the "variation in the distribution of possible outcomes, their likelihoods and their subjective values".

Ho et al. (2015:5035) stated that supply chain risk is "the likelihood and impact of unexpected macro and/or micro level events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities".

As stated by Heckmann et al. (2015:125), supply chain vulnerability is defined as "the concept used to describe the extent to which a supply chain is susceptible to a specific or unspecific risk event". These risks can arise within the supply chain, coming from internal sources, such as human errors and communication problems, as well as be external to it, for instance terrorism and natural disasters (Lei & MacKenzie, 2019).

According to Christopher and Peck (2004), risk exists within the focal firm's boundaries, such as in its processes; however, it is likewise present externally to the firm, both upstream and downstream in the supply chain. Critical sources of risks can be environmental issues, such

as natural disasters, terrorism, wars, economic policies and regulations, among other, being unpredictable – the supply chains must be able to endure these risks (Christopher & Peck, 2004).

Christopher (2016) identified five sources of risk in the SC: Supply risk (how vulnerable the business is to disruptions in supply); Demand risk: (if the demand is volatile, the risk will be higher, causing bullwhip effect); Process risk (the bottlenecks of the process may be crucial, and affect the resilience of the process); Control risk (the internal control systems of the company may also cause disturbances in the SC) and Environmental risk (external events, despite not being able to forecast, must be taken into account, in order to assess its possible impact on the SC). Figure 2.1 illustrates the connection between the five sources of risk previously described.

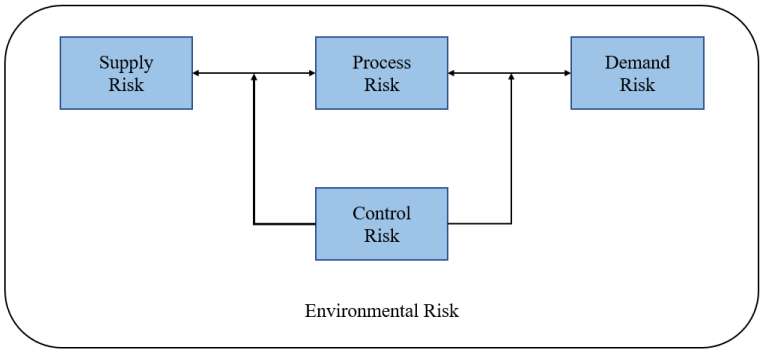

Figure 2.1 – Sources of risk in the supply chain. Source: Christopher (2016).

This framework in Figure 2.1 was originally proposed by Mason-Jones and Towill (1998) and was also used in the research conducted by Christopher and Peck (2004). The process and control risk are internal risks to the firm; supply and demand risk are external to the firm, but internal to the supply chain network and environmental risk is external to the supply chain network. Supply risk relates to upstream disruptions in the supply chain network, whereas demand risk is concerned with the downstream disruptions. These disruptions may affect the firm, causing a disturbance in the material, product and information flow. The environmental risk may disturb directly the firm, or the upstream and downstream network, producing disruptions in the entire supply chain network.

Ho et al. (2015) created a conceptual framework of the types of supply chain risks, illustrated in Figure 2.2. These researchers divided supply chain risks into two major categories – macro risks, and micro risks. Sodhi et al. (2012) characterized them as catastrophic and operational and Tang (2006) as disruption and operational. Regarding macro risks, they are

defined as rare external events or situations that might impact firms negatively, such as natural risks (namely earthquakes and weather disasters) and man-made risks (political instability, war and terrorism); micro risks are linked to the internal activities of the firms that are relatively recurrent (Ho et al., 2015). According to the same author, in general, the first category has a significantly higher negative impact on companies. Ho et al. (2015) states that these risks are divided into four sub-categories: demand and supply risk (adverse events along the SC), manufacturing risk (events that affect the firm's internal ability to produce) and infrastructural risk (information technology (Chopra & Sodhi, 2004), transportation (Wu et al., 2006) and financial systems (Chopra & Sodhi, 2004)).

As Figure 2.2 suggests, SC risks can be of two major categories: micro risks, linked to the activities of the firm (information, transportation, financial, supply, demand and manufacturing) and macro risks, associated with the outside of the firm (man-made and nature). All the aforementioned categories of risk are interlinked in this framework, being clear that, if a disruption occurs, the manufacturing of the company, present in the centre of this framework, can be greatly affected.

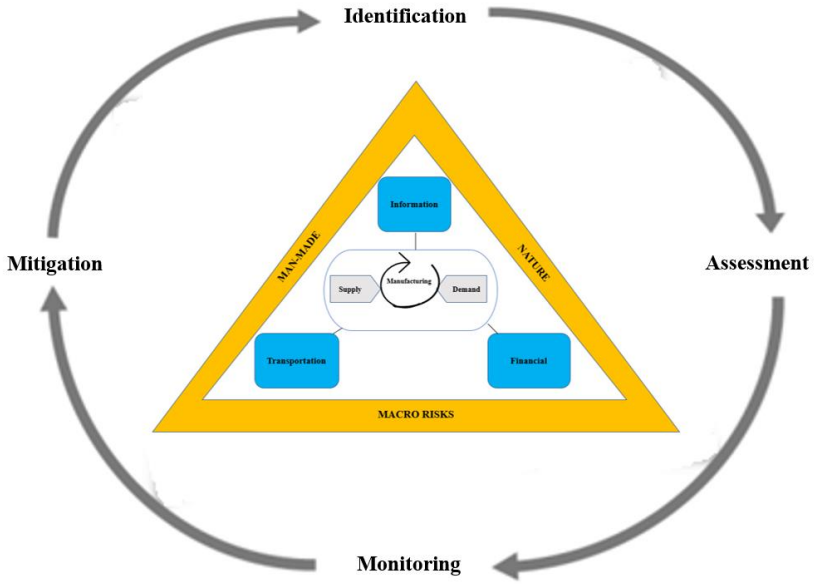

Figure 2.2 – Conceptual framework of supply chain risks. Source: Ho et al. (2015).

Christopher (2016) suggests that a supply chain risk profile should be established for the firm, with the purpose of identifying the greatest vulnerabilities to the SC and the probability of the disruption to occur, making it equal to the probability of disruption times its impact, translating in Equation 1:

$$\text{Supply chain risk} = \text{Probability of disruption} \times \text{Impact} \quad (1)$$

Christopher and Peck (2004) and Yang et al. (2012) use the same approach, relating risk to supply chain vulnerability, referring that the supply chain risk is equal to the probability of a certain event times its severity (the negative impact in the business), using risk as a synonym of "vulnerable" and "likely to be lost or damaged" (Christopher & Peck, 2004:3). A very similar approach is taken by Manuj and Mentzer (2008), adding to the definition that the negative impacts can also have qualitative implications, instead of solely quantitative implications.

As seen before, events impossible to forecast may affect even the best managed supply chains. It is critical to build resilience into them: resilience implies the ability of a system to return to its original or desired state after being disturbed - resilient processes are flexible and agile and are capable of changing quickly (Christopher, 2016).

2.4 External Risk Factors and Delays in Receivements from Suppliers

Disruptions in the SC involve the flow of products, materials, and information across the supply chain network – from the original supplier, delivery and to the final consumer (Jüttner et al., 2003).

Sato (2018) states that when analysing supply disruptions risk, one of the most challenging aspects is dealing with the subjectiveness in risk perception and uncertainties among supply chain, which in turn, influences the strategy for supply chain management.

The perspective of a single organisation, or a single person within the organisation, limits the ability to identify and assess risks in the supply chain (Yingvilasprasert et al., 2012). Zsidisin (2003) identified numerous factors that can affect how supply risk is perceived, such as pace of technological advancement and entry barriers (Kraljic, 1983), degree of customer/supplier interaction and the country (Mitchell, 1995), raw materials availability and the supplier (Steele & Court, 1996).

The inability of a supplier organisation in producing the specified quantity demanded by its customers relates to the concept of capacity constraints (Lee et al., 2017). Zsidisin (2003) conducted a research on supplier characteristics that influence the perception of supply risk on supply chain management professionals and found that unpredictable cycle time and capacity constraints were perceived as having significant risk for the focal company.

Sato (2018) presented a research model of supply disruption risk, analysing the perception of supply chain uncertainties and overall supply disruption risk, shown in Figure 2.3. Tse et al. (2016) identified supply chain uncertainties as three uncontrollable factors in the environment of the supply chain: demand, quality, and logistics uncertainties. Demand uncertainty is concerned with a mismatch between the forecast made by the firm and the actual demand and

lack of coordination with suppliers (Sato, 2018); quality uncertainty is related with the quality standards achieved of incoming goods (Sato, 2018); logistics uncertainty causes a delay or an interruption from either logistics partners or the occurrence of natural disasters during the transport of the products to the customer, that may be triggered by labour disputes, terrorism, natural disasters and failures of transportation infrastructures (Chopra & Sodhi, 2004).

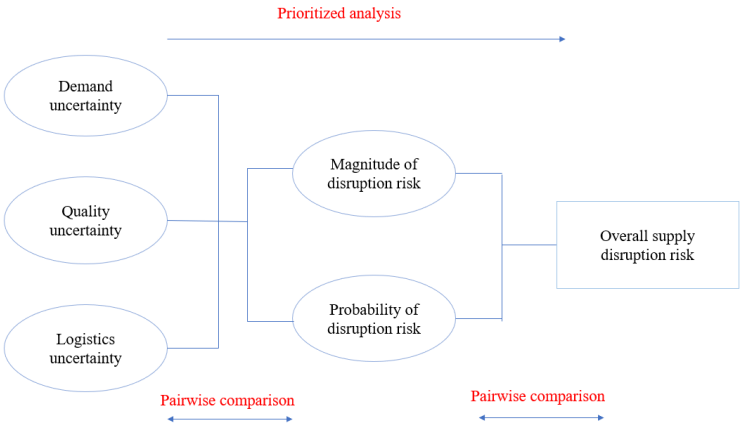

Figure 2.3 – Model of Supply Disruption Risk. Source: Sato (2018)

Sato's (2018) model considers the three uncertainties previously described (demand, quality and logistics) and the relationship between disruption risk, considering the magnitude and probability of occurrence of said risk, and overall supply disruption risk. This approach, observed in the centre of the model present in Figure 2.3, is similar to the one suggested by Christopher and Peck (2004) and Christopher (2016): probability of disruption risk times its magnitude/impact, present in equation 1.

Contemplating the concepts previously described, one may suspect that there may be a link in the perception of the external risk factors and setbacks on the flow of materials and products across the supply chain network. Hence, the following hypothesis is formulated:

- H1: <u>The perception of external risk factors is positively associated with the delays in receivements from suppliers</u>**.**

2.5 External Risk Factors and Delays in Shipments to Clients

Nowadays, many firms operate highly complex and globalized supply chains (MacCarthy et al., 2016). In an ever more competitive market, where companies struggle for surviving, all variables are crucial in order to have a good performance, impacting the efforts on making the goods arrive to consumers at the right time and place (Kusrini et al., 2020).

The ability to deliver products to clients is viewed as an order-qualifier for any marketplace: Ross (2013:41) describes this characteristics as an "order-losing qualifier", enhancing its importance – it is crucial to be able to provide fast and reliable deliveries in today's market, given the customer's high expectations – the transaction, from a customer's perspective, involves not only the product itself, but additionally, "time and how it can be constantly diminished as an essential part of the transaction itself" (Ross, 2013:41).

Mason-Jones and Towill (1998:95) state that "exposure to serious disturbance arising from supply chain risks" affect the "supply chain's ability to effectively serve the end costumer market", meaning that when disruptions occur in the SC, the ability to distribute products or services to the end costumer may suffer setbacks. These facts suggest that the occurrence of disruptions in the SC may be linked to the firm's capacity to ship their orders to the customers. Therefore, the second hypothesis is defined as followed:

- H2: The perception of the external risk factors is positively associated with the delays in shipments to clients.

2.6 Delays in Receivements from Suppliers and Shipments to Clients

A domino effect may occur in a supply chain, caused by uncertainty, that may reach the final client (Giunipero & Eltantawy, 2004). This effect is a result of the "dependences between supply chain links and processes", having the ability to affect companies present in the same network (Wieteska G., 2018: 497).

According to Johnston et al. (2012), one of the service quality factors is reliability, translating into punctual service delivery and the capacity to maintain the contract made with the client. Therefore, it is extremely important to ensure reliability of the delivery to the customers.

A single delay in delivery may provoke a complete stop in the manufacturing process of a firm (Supply Chain Risk Leadership, 2011). Therefore, for a firm, having reliable delivery from their suppliers becomes of the utmost importance, since "delivery variability is disruptive to assembly processes" (Peng and Lu, 2017:886). Hence, if a delay in receivements from the firm's suppliers occurs, there is a possibility that the firm cannot carry a customer's order, being prone to incur in a delay in the fulfilment of the order for the client. Hereupon, these evidences naturally point to a link between the delays in receivements from suppliers and delays in shipments to clients, thereby resulting in the formulation of the third hypothesis:

- H3: The delays in receivements from suppliers are positively associated with delays in shipments to clients.

2.7 Related Work

The topics covered on this thesis - the concept of supply chain and supply chain management, the notion of risk in the supply chain and the sources and types of risks that exist in the supply chain, external risk factors, delays in receivements from suppliers and delays in shipments to clients - have been the subject of several researches. The paper conducted by Todo et al. (2015) examines how supply networks were affected after the Great East Japan Earthquake utilizing firm-level data for 2117 firms in the impacted areas of this disaster, using data prior and after the event, in order to access the impacts on the firms. This study concluded that supply networks are helpful to contribute to the resilience of firms to natural disasters, specially diversified networks, where suppliers and clients are in different locations.

Husdal and Bråthen (2010) conducted a study regarding supply chain disruptions and how businesses and freight carriers located in transportation networks in Norway are affected by and relate to these disruptions. In their conclusions, transportation disruptions do not seem to be a major worry for transportation-dependent businesses, due to the fact that the mitigation and contingent measures seem to be sufficiently handled by the freight carrier, that carries the risk of transportation disruptions, not the businesses themselves, that rely on safety stock or fixed regular deliveries, whereas the carrier must stick to a time schedule, that safeguards delivery.

Yingvilasprasert et al. (2012) organised a research regarding supply chain risk perceptions of Thai companies. This study illustrated the effects of the Great Flood Crisis in 2011 on the firms, by measuring the evaluation of each company to the same risk elements prior and after the event. The most feared risk types prior to the natural disaster were related to demand and supply risk, remaining with the highest score after the event; however, natural disasters' assessing items were all increased after the event.

Tse et al. (2016) focused on the Thai beverage industries and explored the relationship of perception of demand, quality and logistics uncertainties and the representation of supply disruption risk. In particularly, this research detected the existence of a significant relationship between uncertainty in demand and the probability of risk, and between uncertainty in demand and magnitude of risk.

From the analysed researches, it is possible to conclude that companies in different countries, facing different environment conditions, may act differently in their SC.

2.8 Summary

From the research exposed in this chapter, it is possible to conclude that the risk in supply chains is at the outmost importance, in order to achieve and maintain the desired goals for the performance of the organisations.

As stated before, the ability to identify and assess risks in the supply chain may be limited by the perspectives of an organisation (Yingvilasprasert et al., 2012). Behavioural differences in the risk perception can occur when comparing two different countries (Mitchell, 1995). To materialize the comparative analysis of Portugal and Norway, all the hypotheses previously formulated will be subdivided into three partial hypotheses, in order to evaluate possible differences between the two countries where the firms are based. The subdivision of the hypotheses is contemplated on Table 2.1.

Table 2.1 – Hypotheses of the Research

H1	H1.1: The perception of the external risk factors is positively associated with delays in receivements from suppliers in both countries**.**
	H1.2: The perception of the external risk factors is positively associated with delays in receivements from suppliers in Portugal.
	H1.3: The perception of the external risk factors is positively associated with delays in receivements from suppliers in Norway.
H2	H2.1: The perception of the external risk factors is positively associated with delays in shipments to clients in both countries
	H2.2: The perception of the external risk factors is positively associated with delays in shipments to clients in Portugal
	H2.3: The perception of the external risk factors is positively associated with delays in shipments to clients in Norway
H3	H3.1: The delays in receivements from suppliers are positively associated with delays in shipments to clients in both countries
	H3.2 The delays in receivements from suppliers are positively associated with delays in shipments to clients in Portugal
	H3.3: The delays in receivements from suppliers are positively associated with delays in shipments to clients in Norway

The research model that results from the hypotheses previously presented can be viewed in Figure 2.4, where is represented by the possible links between each topic – delays in receivements from suppliers, delays in shipments to clients and external risk factors.

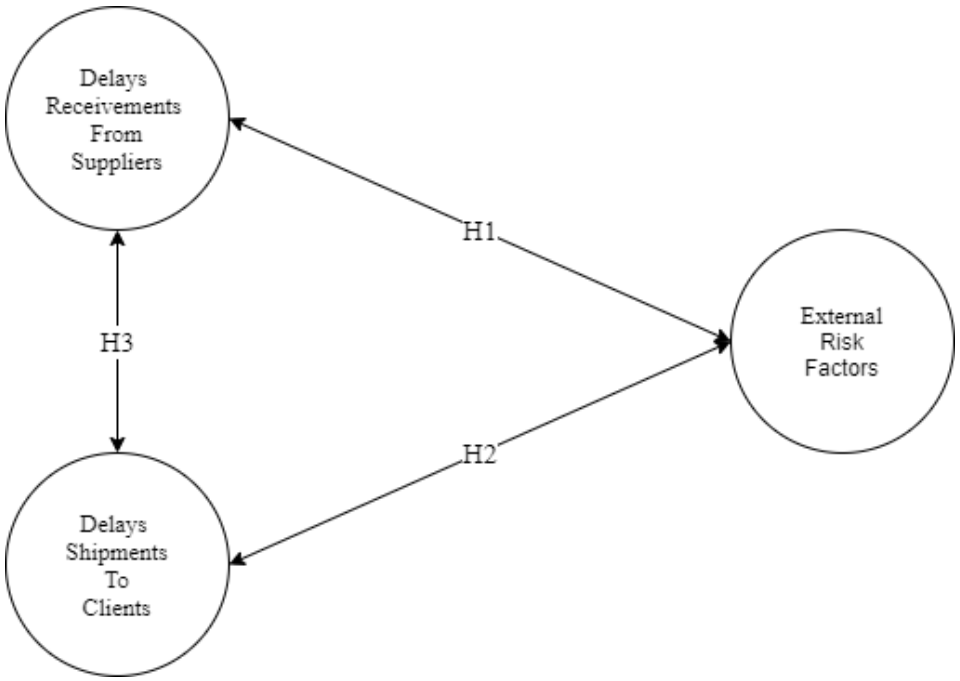

Figure 2.4 – Research Model

CHAPTER 3

Methodology

In this chapter, the methodology adopted in this research will be presented. Initially, an approach to the research design will be conducted, as to address the objectives disclosed in the Introduction; subsequently, the methodological steps and the instruments for analysis will be outlined, for the purpose of testing the hypotheses and produce conclusions.

3.1 Research Design

The data used for the analysis in this work was previously collected using a questionnaire and then organized into a database. The chosen variables from the database came from three separate question groups. It was asked to the firms to reflect only about the most relevant/strategic products that the company buys and sells. The data used in this research concerned four questions about delays in supplier service, four questions about delays in shipments to clients, along the same lines, and a total of eighteen questions about external factors. Each of these questions was transformed into a variable. Regarding the group that is concerned about external factors, it was asked about the probability of occurrence of external disruptions (natural disasters, armed conflicts, terrorism, unstable politic circumstances, accidents, bankruptcy of suppliers, strikes in suppliers, transportation disruptions and restrictions on imports and exports) and the consequences of said disruptions in the firms.

As maintained by Marôco (2018), statistical variables are classified as qualitative (variables that describe data that is not numerical) and quantitative (variables that can be measured on a numeric scale). Quantitative variables can be further distinguished as discrete or continuous (Marôco, 2018).

The variables obtained in the database will be transformed, as to guarantee that the direction of all the variables is equal and categorized in an homogenous way.

3.2 Population and sample size

This database has data from 145 transforming companies of various industry sectors – 92 Norwegian companies, and 43 Portuguese companies. These are manufacturing companies from various sectors, such as farming, plants and animals, textile, food, warehousing, and construction.

3.3 Instruments for data analysis

In view of the analysis of the investigation hypotheses, the conducted method will be similar for all the hypotheses, as the entire set translates into the study of a possible association between independent variables. According to Marôco (2018:14), in correlational studies, the variables are taken into observation and the "information from the study is inferred by a (representative) sample from that population".

The data base does not have a representative sample of the population, therefore the conclusions from this research are only valid under the scope of the sample used.

In order to conduct the research agenda, the analysis of the hypotheses will be performed resorting to composite variables (constructs) built from variables that were present in the database and were subject to transformation. The construction of these variables will be described in detail in chapter 4.

3.3.1 Reliability Analysis

In order to access the internal consistency of a set of variables, Cronbach's alpha is the most commonly used tool – this coefficient is a measure of scale reliability, being a function of the number of variables and the average inter-item covariance between the items (Marôco, 2018). The Cronbach's alpha will increase as the average inter-item correlation increases (Pestana & Gagueiro, 2016). For the purpose of calculating Cronbach's alpha, it is a necessary condition that all the variables are categorized in the same form (Pestana & Gagueiro, 2016).

Preceding the correlation analysis, it is therefore necessary to ensure the reliability of each of the scales present in this study.

3.3.2 Correlation Analysis

Correlation is translated into the degree of statistical relationship between variables, "quantifying the intensity and direction of the association between two variables" (Marôco, 2018:22). According to Pestana and Gagueiro (2016), correlation does not imply causation, as "the association between any two variables X_1 and X_2 is the same as between X_2 and X_1" (Pestana & Gagueiro, 2016:345).

With the purpose of measuring the association between two variables, the most commonly used methods are the Pearson's correlation coefficient and the Spearman's correlation

coefficient (Pestana & Gagueiro, 2016). For the Pearson's correlation coefficient, both variables should follow a normal distribution, due to the fact that this coefficient requires underlying statistical distribution in the data, whereas Spearman's correlation coefficient does not require this assumption, translating into a non-parametric alternative (Pestana & Gagueiro, 2016). In order to verify the normality of a variable, the Kolmogorov-Smirnov test is the most used tool and can be used when the sample size is equal or higher to 30 (Marôco, 2018).

According to Laureano and Botelho (2017), the association between variables is characterized by strength and direction. As stated by the same authors, the strength of the relationship between two variables is obtained by the absolute value of the correlation coefficient, which varies between 0 (no linear relationship) and 1 (perfect relationship) – as the absolute value increases, the relationship will be stronger. Direction is represented by the sign of the correlation coefficient, establishing a positive or direct relationship with a positive coefficient (the variables vary in the same direction), and a negative or inverse relationship with a negative coefficient, meaning that the variables vary in opposite directions (Laureano & Botelho, 2017).

3.4 Summary

Concerning the objectives, the research questions and the hypotheses previously defined in this research, the association among them can be observed in Figure 3.1. The objective 1, "Determine if there is an association between delays in receivements from suppliers and external risk factors" is linked with the research question 1, "Is the risk from external factors associated with delays in receivements from suppliers?", making the hypothesis 1 derive; the objective 2, "Determine if there is an association between delays in shipments to clients and external risk factors" is related with the research question 2, "Is the risk from external factors associated with delays in shipments to clients?" resulting in hypothesis 2; and the objective 3," Determine if there is an association between delays in receivements from suppliers and delays in shipments to clients" is coupled to the research question 3, "Are the delays in receivements from suppliers associated with delays in shipments to clients?", originating hypothesis 3.

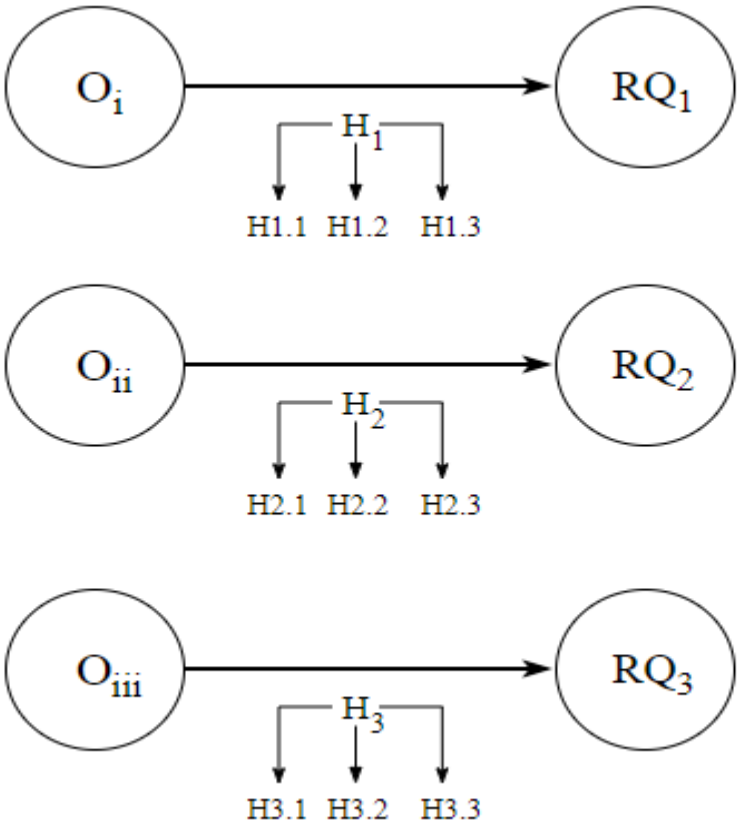

Figure 3.1 – Link between objectives, research questions and hypotheses

CHAPTER 4

Characterisation of the Sample and Construction of the Variables

In this chapter, the sample will be characterised in terms of sector and manufacturing process used by the firms. Afterwards, the development of the composite variables required to test the hypotheses will be thoroughly described, in terms of the approach used for the construction of each composite variable.

4.1 Sample Characterization

The firms that answered to the survey compose a total of 145 transforming companies, that correspond to 92 Norwegian companies and 43 Portuguese companies. These are companies, from multiple sectors, that can be observed in Figure 4.1. The most prevalent sector is the Food sector, that constitutes a total of 31% of the observations, followed by Machinery and Equipment, with a 11,72% of the total of the firms.

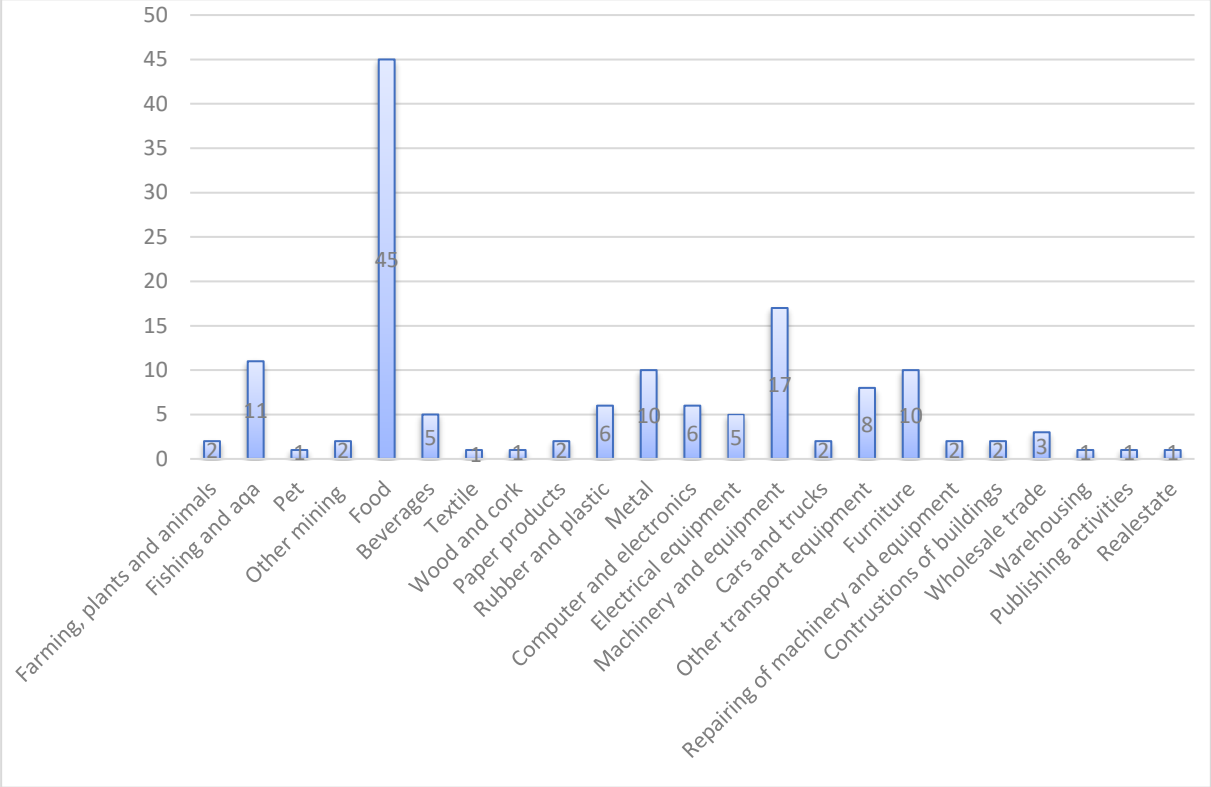

Figure 4.1 – Distribution of the firms by Sectors

The firms can also be categorized by the most prevalent type of production system adopted. According to CSCMP (2020), a manufacturing process strategy can take several forms, such as make-to-stock, make-to-order and engineer-to-order. In a make-to-stock strategy, the finished products are stocked and prepared to fulfil orders; an engineer-to-order process involves a

significant amount of preparation prior to the initiation of the manufacturing process and a make-to-order process requires a customer order before the manufacturing process begins (CSCMP , 2020). In Figure 4.2, the number of firms that employ each production system is exhibited. There is a clear prevalence of the use of make-to-order processes to fulfil customer's orders (over 70% of the inquired firms) – a customer order must be placed in order to initiate the manufacturing of the products; however, 66% of the inquired firms operate make-to-stock manufacturing processes, compelling the need of existence of stock to carry out customer's orders. The percentage of companies using more than one manufacturing method is over 74%.

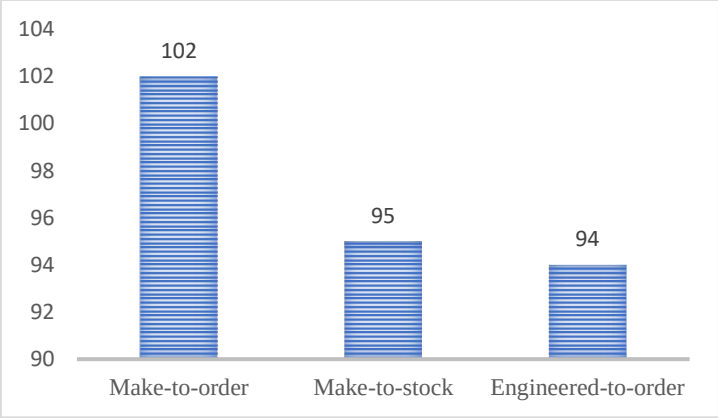

Figure 4.2 – Distribution of the firms by manufacturing process

4.2 Construction of the Variables

In this subchapter, the construction of the composite variables used in this research will be approached. As stated by Fine et al. (2013:1), a "composite variable is a variable made up of two or more variables or measures that are highly related to one another conceptually or statistically". According to the same authors, the use of composite variables enables the arrangement of various highly correlated variables and translates into more relevant information, as each variable is not able to convey enough information; however, by combining the variables into a composite variable, it is possible to illustrate a more elaborated concept.

Averaging and meaningful grouping are the most common approaches to creating composite variables (Fine et al., 2013). Three theoretical constructs were defined in this research, and eleven composite variables were used – the first concerning delays in receivements from suppliers and the second related to delays in shipments to clients; the remain are associated with risk in the SC: three refer to the occurrence of external risks in the SC, divided by global, micro and macro risks; three contemplate the financial impact on the firm of each external risk, each relating to global, micro and macro external risk, respectively; and the last three correspond to the perception of external global, micro and macro risk in the SC.

The process applied to the creation of the first and second composite variables was averaging, where it was calculated the average of the four variables that originated these composite variables, assigning the same weight to all. The composite variables that refer to the occurrence and financial impact of the occurrence of external SC risk derived from the averaging of nine variables, also applying the same weight to these variables. The remaining composite variables arose from the multiplication of these last referred variables.

The direction of the scale applied to all variables was ensured to be the same: the lowest value of the scale corresponds to the most favourable scenario for the company, whereas the highest value illustrate the worst situation.

4.2.1 Composite Variable X_1 – *Delays in receivements from suppliers*

In the matter of the composite variable X_1 – *Delays in receivements from suppliers*, four variables were employed in its construction. Three of these variables were further recoded, in order to present a 5-point Likert scale.

The first variable, $X_{1.1}$ – *Frequency of receivements from suppliers*, had 143 answers and 2 missing values. This variable initially had seven intervals, and was recoded to present five intervals: 1 – Rarely (two times per week or less); 2 – Less often (once a week); 3 – Often (2 times per week); 4 –Very often (3 times per week); 5 – Extremely Often (Several times per day). A higher frequency of receivements from suppliers may result in a higher number of delays in receivements from suppliers, hence the direction of the scale used.

The second variable, $X_{1.2}$ – *Delivery time from the most important suppliers*, exhibited 132 valid answers and 13 missing answers. In the database, this variable was scaled in number of days, and was recoded to display 5 intervals: 1- One or Two days; 2 – Three to Seven Days; 3 –Eight to Fourteen Days; 4 –Fifteen to Sixty Days; 5 – More than Two Months. A lower supplier lead time is desired, ensuing a decrease in the company's lead time (Muckstadt & Sapra, 2016).

The third variable, $X_{1.3}$ - *Frequency of rush orders made to the most important suppliers*, showed 137 valid answers and 8 missing answers. In spite of presenting five intervals, there was the need to invert the scale of this variable, thus maintaining the direction of the scale of the other variables. Therefore, the intervals are the following: 1 – Rarely (less than once a month); 2 – Less often (once a month); 3 – Often (once every two weeks); 4 – Very often (once a week); 5 – Extremely Often (2 - 3 times per week). A higher number of rush orders to the suppliers is not a sought-after situation for the company, since rush orders are "a challenging

risk for supply chains, due to their nature of pre-emption over regular orders processing." (Arisha & Mahfouz, 2010:7).

The fourth variable, $X_{1.4}$ - *Frequency of delays from suppliers*, had 142 valid answers and 3 missing answers. In the database, this variable already exhibited five intervals, in the required direction: 1 – Very Rarely; 2 – Rarely; 3 – Occasionally; 4 –Very frequently; 5 – Almost always. Delays from suppliers are not a suitable situation for the company, due to the fact that a delay in receivements from suppliers may cause disruptions in the company's manufacturing processes (Peng & Lu, 2017).

4.2.2 Composite Variable X_2 – *Delays in shipments to clients*

The construction of the composite variable X_2 – *Delays in shipments to clients* was conducted equivalently to the previous presented variable. Four variables were used, and recoded when necessary.

The first variable, $X_{2.1}$ – *Frequency of shipments to clients*, had 134 answers and 11 missing values. This variable initially had six intervals and was recoded to display five intervals: 1 – Rarely (once every two weeks or less); 2 – Less often (once a week); 3 – Often (two times per week); 4 – Very often (3 times per week); 5 – Extremely Often (everyday). A lower frequency of shipments to clients may result in a lower frequency of delays, translating into a more favourable situation for the company.

The second variable, $X_{2.2}$ – *Delivery time in orders sent to clients*, exhibited 133 valid answers and 12 missing answers. This variable was initially scaled in number of days, and was further recoded to present five intervals: 1 – More than Two Months; 2 – Fifteen to Sixty Days; 3 –Eight to Fourteen Days; 4 – Two to Seven Days; 5 –Less than Two days.

The third variable, $X_{2.3}$ - *Frequency of rush orders from clients*, showed 125 valid answers and 20 missing answers. This variable displayed five intervals; however, it was required to invert the scale of this variable, as to assure the same direction of the scale of the other variables. Therefore, the intervals are the following: 1 – Rarely (less than once a month); 2 – Less often (once a month); 3 – Often (once every two weeks); 4 –Very often (once a week); 5 – Extremely Often (2 - 3 times per week). As stated previously, rush orders are a risk for the supply chain (Arisha & Mahfouz, 2010).

The fourth variable, $X_{2.4}$ - *Frequency of delays in orders sent to clients*, had 130 valid answers and 15 missing answers. This variable was not subject to any transformation, exhibiting 5 intervals: 1 – Very Rarely; 2 – Rarely; 3 – Occasionally; 4 –Very frequently; 5 – Almost

always. As stated by Johnston et al. (2012), timely delivery of service and upholding the deal made with the customer is highly necessary to ensure reliability for the client.

4.2.3 Composite Variable $X_{3.1}$ – *Probability of disruption (external global risks)*

The composite variable $X_{3.1}$ – *Probability of disruption (external global risks),* had 125 valid answers and 20 missing answers, and resulted from the aggregation of 9 variables, defined as:

$X_{3.1.1}$ - *Probability of occurrence of natural disasters*;

$X_{3.1.2}$ - *Probability of occurrence of armed conflicts*;

$X_{3.1.3}$ - *Probability of occurrence of terrorism*;

$X_{3.1.4}$ - *Probability of occurrence of unstable political circumstances*;

$X_{3.1.5}$ - *Probability of occurrence of accidents*;

$X_{3.1.6}$ - *Probability of occurrence of suppliers' bankruptcies*;

$X_{3.1.7}$ - *Probability of occurrence of suppliers' strikes*;

$X_{3.1.8}$ - *Probability of occurrence of transport issues;*

$X_{3.1.9}$ - *Probability of occurrence of restrictions on imports/exports.*

All the aforementioned variables present a 5-point Likert Scale, established as: 1 – Highly Unlikely; 2 - Unlikely; 3 – Neither Likely Nor Unlikely; 4 - Likely ; 5 – Highly Likely.

4.2.4 Composite Variable $X_{3.2}$ – *Financial consequences of disruption (external global risks)*

The composite variable $X_{3.2}$ – *Financial consequences of disruption (external global risks)* presented 122 valid answers and 23 missing answers. This variable arose from the averaging of nine variables, defined as follows:

$X_{3.2.1}$ – *Financial consequences of natural disasters*;

$X_{3.2.2}$ - *Financial consequences of armed conflicts*;

$X_{3.2.3}$ - *Financial consequences of terrorism*;

$X_{3.2.4}$ - *Financial consequences of unstable political circumstances*;

$X_{3.2.5}$ - *Financial consequences of accidents*;

$X_{3.2.6}$ - *Financial consequences of suppliers' bankruptcies*;

$X_{3.2.7}$ - *Financial consequences of suppliers' strikes*;

$X_{3.2.8}$ - *Financial consequences of transport issues;*

$X_{3.2.9}$ - *Financial consequences of restrictions on imports/exports.*

The scale used in these variables was a 5-point Likert scale with the following meaning per point: 1 – Minimal Financial Consequences; 2 – Minor Financial Consequences; 3 – Moderate Financial Consequences; 4 – Significant Financial Consequences ; 5 – Severe Financial Consequences.

4.2.5 Variable X_3 – *Perception of external global risks*

Regarding the variable X_3 – *Perception of external global risks,* the two variables previously mentioned were used in its construction. As maintained by Christopher (2016), Yang et al. (2012) and Manuj and Mentzer (2008), the approach for supply chain risk carries the probability of occurrence of a certain event times its negative impact in the firm's business, resulting in Equation 1, previously referred in Chapter 2. As a result, this variable is the multiplication of the variable $X_{3.1}$ – *Probability of Disruption (External Risks)* with the variable $X_{3.2}$ – *Financial consequences of disruption (external risks)*, illustrated in Equation 2.

$$X_3 = X_{3.1} * X_{3.2} \quad (2)$$

4.2.6 Composite Variable $X_{3.1\_Macro}$ – *Probability of disruption (external macro risks)*

As seen in Chapter 2 and as stated by Ho et al. (2015), risks in the supply chain can be classified into two main groups: macro and micro risks. As claimed by the same author, macro risks are composed of nature and man-made risks – rare global incidents or circumstances that may negatively affect businesses. As a result, the composite variable $X_{3.1\_Macro}$ – *Probability of disruption (external macro risks)* was built as an average of the variables $X_{3.1.1}$, $X_{3.1.2}$, $X_{3.1.3}$, $X_{3.1.4}$ and $X_{3.1.5}$ (probability of occurrence of natural disasters, armed conflicts, terrorism, unstable political circumstances and accidents, respectively), containing the external macro risks, and had 123 valid answers and 22 missing answers.

4.2.7 Composite Variable $X_{3.2\_Macro}$ – *Financial consequences of disruption (external macro risks)*

The composite variable $X_{3.2\_Macro}$ – *Financial consequences of disruption (external macro risks)* presented 117 valid answers and 28 missing answers, and was constructed as the average of the variables $X_{3.2.1}$, $X_{3.2.2}$, $X_{3.2.3}$, $X_{3.2.4}$ and $X_{3.2.5}$ (financial consequences of natural disasters, armed conflicts, terrorism, unstable political circumstances and accidents, respectively).

4.2.8 Variable X_{3_Macro} – *Perception of external macro risks*

The variable X_{3_Macro} – *Perception of external macro risks* resulted from the multiplication of the variables $X_{3.1\_Macro}$ - *Probability of disruption (external macro risks)* and $X_{3.2\_Macro}$ - *Financial consequences of disruption (external macro risks)*, illustrated in Equation 3. This variable arose from the approach of supply chain risk made by Christopher (2016), Yang et al. (2012) and Manuj and Mentzer (2008), present in Equation 1, in Chapter 2.

$$X_{3\_Macro} = X_{3.1\_Macro} * X_{3.2\_Macro} \quad (3)$$

4.2.9 Composite Variable $X_{3.1\_Micro}$ – *Probability of disruption (external micro risks)*

The composite variable $X_{3.1\_Micro}$ – *Probability of disruption (external micro risks)* had 118 valid answers and 27 missing answers. As declared by Ho et al. (2015), micro risks are attributable to the organizations' internal operations, which are generally frequent. Therefore, the variable $X_{3.1\_Micro}$ derived from the average of the variables $X_{3.1.6}$, $X_{3.1.7}$, $X_{3.1.8}$ and $X_{3.1.9}$ (probability of occurrence of suppliers' bankruptcies, suppliers' strike, transport issues and restrictions on imports/exports, respectively).

4.2.10 Composite Variable $X_{3.2\_Micro}$ – *Financial consequences of disruption (micro external risks)*

Concerning the composite variable $X_{3.2\_Micro}$ – *Financial consequences of disruption (external micro risks)* it was constructed as the average of the variables $X_{3.2.6}$, $X_{3.2.7}$, $X_{3.2.8}$ and $X_{3.2.9}$ (financial consequences of suppliers' bankruptcies, suppliers' strike, transport issues and restrictions on imports/exports, respectively), having 168 valid and 29 missing answers.

4.2.11 Variable X_{3_Micro} - *Perception of external micro risks*

Similarly to the variables X_3 and X_{3_Macro}, the variable X_{3_Micro} - *Perception of external micro risks* was constructed based on Equation 1, proposed by Christopher (2016). Thereupon, this variable was developed as the multiplication of the variables $X_{3.1\_Micro}$ - *Probability of disruption (external micro risks)* and $X_{3.2\_Micro}$ – *Financial consequences of disruption (external micro risks)*, inferred in Equation 4.

$$X_{3\_Micro} = X_{3.1\_Micro} * X_{3.2\_Micro} \quad (4)$$

CHAPTER 5

Findings and Discussion of Results

In this fifth chapter, the findings raised from the data analysis concerning delays in receivements from suppliers, delays in shipments to clients and the perception of external risk factors in the supply chain in manufacturing companies based in Portugal and Norway will be described and discussed.

This chapter will be initiated with a reliability analysis of the composite variables used in the research. Following this, the correlational research will be provided, as to assess the validity of the constructs and the decision of the investigation hypotheses. Afterwards, the discussion of the results will be addressed.

5.1 Reliability Analysis

In order to proceed to the analysis of the constructs built in this research, it is crucial to verify the internal consistency of the composite variables. As previously referred, this analysis can be conducted through Cronbach's Alpha.

5.1.1 Composite Variable X_1 – *Delays in receivements from suppliers*

Table 5.1 illustrates the Cronbach's Alpha value for composite variable X_1 – *Delays in receivements from suppliers.* A higher value of the alpha translates into a higher correlation between the variables tested (Tavakol & Dennick, 2011). Nonetheless, "a high coefficient alpha does not always mean a high degree of internal consistency. If the test length is too short, the value of alpha is reduced" (Tavakol & Dennick, 2011:1), meaning that the Cronbach's alpha is also affected by the size of the sample used. Therefore, despite the value for the Cronbach's Alpha being 0,243, it can indicate that the variables are moderately homogeneous, as it is placed between 0,2 and 0,4 (Piedmont, 2014).

Table 5.1 – Cronbach's Alpha Coefficient for variable X_1 – *Delays in receivements from suppliers*

Cronbach's Alpha	N of Items
,243	4

In Table A.1, Annex A, it is represented in detail the contribution of every variable used in the construction of the variable X_1 for the scale mean and scale variance, the corrected item-total

correlation, the squared multiple correlation and the value of the Cronbach's alpha if the variable is deleted. If any of the items were deleted, the value of the Cronbach's alpha slightly improved if the variables $X_{1.3}$ or $X_{1.4}$ were deleted; however, all variables were kept in the construction of the variable X_1, as the sample size is small and the construct is theoretically enriched with the entire set of variables.

5.1.2 Composite Variable X_2 – *Delays in shipments to clients*

Cronbach's Alpha value for the composite variable X_2 – *Delays in shipments to clients* corresponds to 0,530, as seen in Table 5.2. According to Hinton et al. (2014), an obtained value for the Cronbach's alpha situated between 0,5 and 0,7 indicates moderate reliability between items.

Table 5.2 – Cronbach's Alpha Coefficient for variable X_2 – *Delays in shipments to clients*

Cronbach's Alpha	N of Items
,530	4

The value of the Cronbach's alpha undergoes a significant improvement if the variable $X_{2.4}$ is eliminated, as Table A.2 (Annex A) illustrates; despite this, all items have been retained in the construction of this variable, as the theoretical consistence is greater and the sample size is not vast.

5.1.3 Composite Variable $X_{3.1}$ – *Probability of disruption (external global risks)*

In Table 5.3, the Cronbach's Alpha value for the composite variable $X_{3.1}$ – *Probability of disruption (external global risks)* is displayed, being equal to 0,753. As referred by Hinton et al. (2014), this alpha score indicates high reliability, as it is a value between 0,70 and 0,90.

Table 5.3 – Cronbach's Alpha Coefficient for Variable $X_{3.1}$ – *Probability of disruption (external global risks)*

Cronbach's Alpha	N of Items
,753	9

As seen in Table A.3 (Annex A), the value of the Cronbach's alpha if any of the items are deleted does not experience improvements; thus, in the construction of this variable, all items were preserved.

5.1.4 Composite Variable $X_{3.2}$ – *Financial consequences of disruption (external global risks)*

The value of the Cronbach's alpha of the composite variable $X_{3.2}$ – *Financial consequences of disruption (external global risks)* is present on Table 5.4, being equal to 0,898. As maintained by Hinton et al. (2014), this score manifests high reliability between items.

Table 5.4 – Cronbach's Alpha Coefficient for variable $X_{3.2}$ – *Financial consequences of disruption (external global risks)*

Cronbach's Alpha	N of Items
,898	9

According to Table A.4, in Annex A, the value of the Cronbach's alpha does not increase if any of the items are deleted; therefore, all the variables were maintained in the construction of the composite variable $X_{3.2}$ – *Financial consequences of disruption (external global risks)*.

5.1.5 Composite Variable $X_{3.1\_Macro}$ – *Probability of disruption (external macro risks)*

Cronbach's Alpha for the composite variable $X_{3.1\_Macro}$ – *Probability of disruption (macro external risks)* can be found in Table 5.5, being equal to 0,752, showing that the items have high reliability, as maintained by Hinton et al. (2014).

Table 5.5 – Cronbach's Alpha Coefficient for variable $X_{3.1\_Macro}$ – *Probability of disruption (macro external risks)*

Cronbach's Alpha	N of Items
,752	5

Provided that if any of the elements are omitted, the value of Cronbach's alpha does not increase, as observed in Table A.5 (Annex A); thus, all the variables have been preserved in the composite variable's construction.

5.1.6 Composite Variable $X_{3.2\_Macro}$ – *Financial consequences of disruption (external macro risks)*

Table 5.6 shows the value of the Cronbach's Alpha for the Composite Variable $X_{3.2\_Macro}$ – *Financial consequences of disruption (External Macro Risks),* being equal to 0,920.This value demonstrates very high reliability between items (Hinton et al., 2014).

Table 5.6 – Cronbach's Alpha Coefficient for Variable $X_{3.2\_Macro}$ – F*inancial consequences of disruption*

Cronbach's Alpha	N of Items
,920	5

As identified in Table A.6 (Annex A), the removal of the variable $X_{3.2.5}$ provides a minor improvement in the Cronbach's alpha; nevertheless, in the development of this variable, all elements have been preserved, as the theoretical accuracy is greater and the sample size is not wide.

5.1.7 Composite Variable $X_{3.1\_Micro}$ – *Probability of disruption (external micro risks)*

Table 5.7 indicates a value of 0,676 for the Cronbach's Alpha related to the composite variable $X_{3.1\_Micro}$ – *Probability of disruption (external micro risks).* This value reveals moderate reliability between items (Hinton, 2014).

Table 5.7 – Cronbach's Alpha Coefficient for variable $X_{3.1\_Micro}$ – *Probability of disruption (external micro risks*

Cronbach's Alpha	N of Items
,676	4

All items were used in the construction of this variable, as the value of the Cronbach's Alpha is not enhanced with the deletion of any of the items, as seen in Table A.7, in Annex A.

5.1.8 Composite Variable $X_{3.2\_Micro}$ – *Financial consequences of disruption (external micro risks)*

Cronbach's Alpha for the composite variable $X_{3.2\_Micro}$ – *Financial consequences of disruption (external micro risks)* is displayed in Table 5.8, corresponding to 0,791; this translates into an inter-item high reliability (Hinton, 2014).

Table 5.8 – Cronbach's Alpha Coefficient for variable $X_{3.2\_Micro}$ – *Financial consequences of disruption (external micro risks)*

Cronbach's Alpha	N of Items
,791	4

Table A.8 (Annex A) shows that there is a minor improvement on the Cronbach's Alpha value if the variable $X_{3.2.9}$ is deleted; however, all elements have been incorporated in the formulation of this variable, as the sample size is not high and the theoretical precision is greater.

5.2 Correlational Analysis

As previously mentioned, the measurement of the association between two variables can be conducted through the use of Pearson's correlation coefficient or Spearman's correlation coefficient (Pestana & Gagueiro, 2016). All variables used in the correlational analysis were subjected to the Kolmogorov-Smirnov test to access normality, as the sample size is higher than thirty. The results are illustrated in Table B.1, Annex B. According to Laureano and Botelho (2017), for a significance level of 0,05, H_0 is rejected if $sig < 0{,}05$, suggesting that the variable does not follow a normal distribution. The results of the Kolmogorov-Smirnov Tests do not confirm the normality assumption for all variables used.

Given this fact, Spearman's correlation coefficient should be used in the correlation analysis, as it is the non-parametric alternative (Pestana & Gagueiro, 2016).

As stated by Laureano and Botelho (2017), in order to measure the association between two variables, three aspects must be evaluated: strength, direction and significance.

5.2.1 H1.1 - *The perception of the external risk factors* is *positively associated with delays in receivements from suppliers in both countries*

The Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_3 - P*erception of external global risk*, for both countries, in Table 5.9, is equal to 0,098. The strength of this relationship, measured by the absolute value of the coefficient, is considered weak, as the value is lower than 0,2 (Laureano & Botelho, 2017) and the relationship is not significant, as the *sig* value (0,313) is higher than 0,05 (Marôco, 2018); nonetheless, the variables have are positively associated.

Table 5.9 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_3 - P*erception of external global risks*, in both countries

Portugal and Norway			X_1- D*elays in receivements from suppliers*	X_3 - P*erception of external global risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,098
		Sig. (2-tailed)		,313
		N	127	109
	X_3 - P*erception of external global risks*	Correlation Coefficient	,098	1
		Sig. (2-tailed)	,313	
		N	109	122

Table 5.10 shows the correlation coefficient (-0,008) and the sig value (0,938) for variables X_1 - D*elays in receivements from suppliers* and X_{3_Macro} - P*erception of external macro risk*. As the value of the coefficient is very close to 0 (no linear relationship) and the sig value is very high, these results suggest that there is no link between the perception of external macro risk factors and the delays in receivements from suppliers in both countries (Laureano & Botelho, 2017; Marôco, 2018).

Table 5.10 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_{3_Macro} - *Perception of external macro risks*, in both countries

Portugal and Norway			X_1- D*elays in receivements from suppliers*	X_{3_Macro} - P*erception of external macro risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	-,008
		Sig. (2-tailed)	.	,938
		N	127	104
	X_{3_Macro} - *Perception of external macro risks*	Correlation Coefficient	-,008	1
		Sig. (2-tailed)	,938	.
		N	104	116

Regarding the association between X_1 - D*elays in receivements from suppliers* and X_{3_Micro} - P*erception of external micro risk*, illustrated in Table 5.11, the correlation coefficient is equal to 0,141 and the sig value is 0,155 – these findings also point to a weak and non-significant relationship between the variables (Laureano & Botelho, 2017; Marôco, 2018); nonetheless, the variables have a low positive association.

Table 5.11 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_{3_Micro} - *Perception of external micro risks*, in both countries

Portugal and Norway			X_1- D*elays in receivements from suppliers*	X_{3_Macro} - P*erception of external Micro risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,141
		Sig. (2-tailed)	.	,155
		N	127	103
	X_{3_Micro} - *Perception of external Micro risks*	Correlation Coefficient	,141	1
		Sig. (2-tailed)	,155	.
		N	103	113

The decision is the rejection of H1.1, as these results show that, despite there is a slight positive relationship between the perception of the global external risk factors and the delays in receivements from suppliers, and external micro risk factors and the delays in receivements from suppliers in both countries, the relationship between the variables is weak and statistically non-significant.

5.2.2 H1.2 - *The perception of the external risk factors* is **positively associated with delays in receivements from suppliers in Portugal**

In Table 5.12, it is possible to verify that the variables X_1- D*elays in receivements from suppliers* and X_3 - P*erception of external global risks* are positively associated (Pearson's correlation coefficient is equal to 0,230, resulting in a weak association); however, the relationship is not significant, as the sig value is higher than 0,05 (Marôco, 2018).

Table 5.12 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_3 - *Perception of external global risks*, in Portugal

Portugal			X_3- *Perception of external global risks*	X_1- D*elays in receivements from suppliers*
Spearman's Rho	X_3- *Perception of external global risks*	Correlation Coefficient	1	,230
		Sig. (2-tailed)	.	,153
		N	48	40
	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	,230	1
		Sig. (2-tailed)	,153	.
		N	40	42

As seen in Table 5.13, the correlation coefficient of the variables X_1 - D*elays in receivements from suppliers* and X_{3_Macro} - *Perception of external macro risks* is equal to 0,027 and the sig value is 0,871. This data presents a very weak and non-significant association between the variables (Marôco , 2018).

Table 5.13 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_{3_Macro} - *Perception of external macro risks*, in Portugal

Portugal			X_1- D*elays in receivements from suppliers*	X_{3_Macro} - P*erception of external macro risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,027
		Sig. (2-tailed)	.	,871
		N	48	38
	X_{3_Macro} - *Perception of external macro risks*	Correlation Coefficient	,027	1
		Sig. (2-tailed)	,871	.
		N	38	40

Table 5.14 identifies the association between variables X_1 - D*elays in receivements from suppliers* and X_{3_Micro} - *Perception of external micro risks* – the correlation coefficient is 0,313 and the sig value is 0,052. These findings point to an existing moderate positive association between the variables, that is not significant at the 0,05 level; however, for a 0,06 significant level, this correlation would be considered significant (Marôco, 2018; Laureano & Botelho, 2017).

Table 5.14 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_{3_Micro} - *Perception of external micro risks*, in Portugal

Portugal			X_1- D*elays in receivements from suppliers*	X_{3_Micro} - P*erception of external micro risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,313
		Sig. (2-tailed)	.	,052
		N	48	39
	X_{3_Micro} - *Perception of external micro risks*	Correlation Coefficient	,313	1
		Sig. (2-tailed)	,052	.
		N	39	41

The decision is the rejection of H1.2: despite the fact that the variables are positively correlated, translating into a positive relationship between the perception of the external risk factors and delays in receivements from suppliers in Portugal, the relationships analysed are not significant nor strong.

5.2.3 H1.3 - *The perception of the external risk factors* is *positively associated with delays in receivements from suppliers in Norway*

Table 5.15 shows a Spearman's correlation coefficient of 0,003 and a sig value of 0,982 for variables X_1 - D*elays in receivements from suppliers* and X_3 - *Perception of external global risks*. According to Marôco (2018) and Laureano and Botelho (2017), these values suggest a very weak, almost non-existing, and non-significant association between the variables.

Table 5.15 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_3 - *Perception of external global risks*, in Norway

Norway			X_1- D*elays in receivements from suppliers*	X_3 - P*erception of external global risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,003
		Sig. (2-tailed)	.	,982
		N	79	69
	X_3 - *Perception of external global risks*	Correlation Coefficient	,003	1
		Sig. (2-tailed)	,982	.
		N	69	80

The association analysis between the variables X_1 - D*elays in receivements from suppliers* and X_{3_Macro} - *Perception of external macro risks* also points to an almost non-existing and non-significant relationship between the variables, as the correlation coefficient is -0,025 and the sig value is 0,845, as illustrated in Table 5.16.

Table 5.16 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_{3_Macro} - *Perception of external macro risks*, in Norway

Norway			X_1- D*elays in receivements from suppliers*	X_{3_Macro} - P*erception of external macro risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	-,025
		Sig. (2-tailed)	.	,845
		N	79	66
	X_{3_Macro} - *Perception of external macro risks*	Correlation Coefficient	-,025	1
		Sig. (2-tailed)	,845	.
		N	66	76

Table 5.17 reveals a correlation coefficient of 0,014 and a sig value of 0,910 for the correlational analysis of the variables X_1 - D*elays in receivements from suppliers* and X_{3_Micro} - *Perception of external micro risks*. These findings also suggest a non-existing and non-significant relationship between the variables (Marôco, 2018; Laureano & Botelho, 2017).

Table 5.17 – Spearman's correlation coefficient for variables X_1 - D*elays in receivements from suppliers* and X_{3_Micro} - *Perception of external micro risks*, in Norway

Norway			X_1- D*elays in receivements from suppliers*	X_{3_Micro} - P*erception of external micro risks*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,014
		Sig. (2-tailed)	.	,910
		N	79	64
	X_{3_Micro} - *Perception of external micro risks*	Correlation Coefficient	,014	1
		Sig. (2-tailed)	,910	.
		N	64	72

The decision is therefore the rejection of H1.3, suggesting that there is no linking in the perception of external risk factors and delays in receivements in suppliers in Norway.

5.2.4 H2.1: *The perception of the external risk factors* *is positively* ***associated with delays in shipments to clients in both countries***

The correlation analysis of the variables X_2 - *Delays in shipments to clients* and X_3 – *Perception of external global risks* is exhibited in Table 5.18 – the correlation coefficient is 0,142 and the sig value is 0,161, translating into a weak and non-significant relationship between the variables (Marôco, 2018; Laureano & Botelho, 2017).

Table 5.18 – Spearman's correlation coefficient for variables X_2 - *Delays in shipments to clients* and X_3 – *Perception of external global risks*, in both countries

Portugal and Norway			X_2 - *Delays in shipments to clients*	X_3 – *Perception of external global risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	,142
		Sig. (2-tailed)	.	,161
		N	114	99
	X_3 – *Perception of external global risks*	Correlation Coefficient	,142	1
		Sig. (2-tailed)	,161	.
		N	99	122

Table 5.19 shows a correlation coefficient of 0,018 and a sig value of 0,865 for X_2 - *Delays in shipments to clients* and X_{3_Macro} – *Perception of external macro risks*, rendering a non-existing and non-significant relationship between the variables (Marôco, 2018).

Table 5.19 – Spearman's correlation coefficient for variables X_2 - *Delays in shipments to clients* and X_{3_Macro} – *Perception of external macro risks*, in both countries

Portugal and Norway			*X_2 - Delays in shipments to clients*	*X_{3_Macro} – Perception of external macro risks*
Spearman's Rho	*X_2 - Delays in shipments to clients*	Correlation Coefficient	1	,018
		Sig. (2-tailed)	.	,865
		N	114	96
	X_{3_Macro} – Perception of external macro risks	Correlation Coefficient	,018	1
		Sig. (2-tailed)	,865	.
		N	96	116

The correlation analysis of the variables X_2 - *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks* illustrated in Table 5.20, shows a significant, yet weak, positive relationship between the variables (Marôco, 2018; Laureano & Botelho, 2017), suggesting that there is a positive association between the perception of the external micro risks and delays in shipments to clients in both countries.

Table 5.20 – Spearman's correlation coefficient for variables X_2 - *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks*, in both countries

Portugal and Norway			*X_2 - Delays in shipments to clients*	*X_{3_Micro} – Perception of external micro risks*
Spearman's Rho	*X_2 - Delays in shipments to clients*	Correlation Coefficient	1	,249*
		Sig. (2-tailed)	.	,015
		N	114	95
	X_{3_Micro} – Perception of external micro risks	Correlation Coefficient	,249*	1
		Sig. (2-tailed)	,015	.
		N	95	113

*. Correlation is significant at the 0.05 level (2-tailed

The decision is the partial rejection of H2.1, as these findings show there is a small significant positive association between the perception of external micro risk factors and the delays in shipments to clients in the two countries, suggesting that the perception of the external micro risk and delays in shipments to clients are positively associated in both countries.

5.2.5 H2.2 - *The perception of the external risk factors* *is positively* ***associated with delays in shipments to clients in Portugal***

Table 5.21 reveals a correlation coefficient of 0,160 and a sig value of 0,345 for X_2 - *Delays in shipments to clients* and X_3 – *Perception of external global risks*. These findings embody a weak, positive and non-significant relationship between the variables (Marôco, 2018; Laureano & Botelho, 2017).

Table 5.21 – Spearman's correlation coefficient for variables X_2 - *Delays in shipments to clients* and X_3 – *Perception of external global risks*, in Portugal

Portugal			X_2 - *Delays in shipments to clients*	X_3 – *Perception of external global risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	,160
		Sig. (2-tailed)	.	,345
		N	42	37
	X_3 – *Perception of external global risks*	Correlation Coefficient	,160	1
		Sig. (2-tailed)	,345	.
		N	37	42

In table 5.22, a correlation coefficient of 0,337 and a sig value of 0,042 for variables X_2 – *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks* are portrayed, revealing a positive, moderate and significant link between the variables (Marôco, 2018; Laureano & Botelho, 2017).

Table 5.22 – Spearman's correlation coefficient for variables X_2 – *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks*, in Portugal

Portugal			X_2 - *Delays in shipments to clients*	X_{3_Micro} – *Perception of external micro risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	,337*
		Sig. (2-tailed)	.	,042
		N	43	37
	X_{3_Micro} – *Perception of external micro risks*	Correlation Coefficient	,337*	1
		Sig. (2-tailed)	,042	.
		N	37	41

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5.23 exposes a correlation coefficient of 0,070 and a sig value of 0,686 for X_2 - *Delays in shipments to clients* and X_{3_Macro} – *Perception of external macro risks*; as stated by Marôco (2018) and Laureano and Botelho (2017), this is a very weak and non-significant, yet positive, association between the variables.

Table 5.23 – Spearman's correlation coefficient for variables X_2 - *Delays in shipments to clients* and X_{3_Macro} – *Perception of external macro risks*, in Portugal

Portugal			X_2 - *Delays in shipments to clients*	X_{3_Macro} – *Perception of external macro risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	,070
		Sig. (2-tailed)	.	,686
		N	43	36
	X_{3_Macro} – *Perception of external macro risks*	Correlation Coefficient	,070	1
		Sig. (2-tailed)	,686	.
		N	36	40

It can be concluded that the variables are associated positively, although only the association between X_2 – *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks* is significant. For this reason, the partial rejection of H2.2 is the decision, since these findings demonstrate that there is a positive significant correlation among the perception of the external micro risk factors and delays in shipments to clients in Portugal.

5.2.6 H2.3 - *The perception of the external risk factors is positively associated with delays in shipments to clients in Norway*

In Table 5.24, the correlation coefficient is quite low (0,077) and the *sig* value is equal to 0,553 for variables X_2 - *Delays in shipments to clients* and X_3 – *Perception of external global risks*, establishing a non-significant, very weak, positive correlation between the two variables (Laureano & Botelho, 2017; Marôco, 2018).

Table 5.24 – Spearman's correlation coefficient for variables X_2 - *Delays in shipments to clients* and X_3 – *Perception of external global risks,* in Norway

Norway			X_2 - *Delays in shipments to clients*	X_3 – *Perception of external global risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	,077
		Sig. (2-tailed)		,553
		N	71	62
	X_3 – *Perception of external global risks*	Correlation Coefficient	,077	1
		Sig. (2-tailed)	,553	
		N	62	80

Table 5.25 shows a correlation coefficient of 0,185 and a sig value of 0,164 between X_2 – *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks*, providing a positive, non-significant and weak association between the two variables (Laureano & Botelho, 2017; Marôco, 2018).

Table 5.25 – Spearman's correlation coefficient for variables X_2 – *Delays in shipments to clients* and X_{3_Micro} – *Perception of external micro risks*, in Norway

Norway			X_2 - *Delays in shipments to clients*	X_{3_Micro} – *Perception of external micro risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	,185
		Sig. (2-tailed)	.	,164
		N	71	58
	X_{3_Micro} – *Perception of external micro risks*	Correlation Coefficient	,185	1
		Sig. (2-tailed)	,164	.
		N	58	72

Table 5.26 states a correlation coefficient of -0,046 and a sig value of 0,727. This indicates a non-significant and almost non-existing, yet negative, relationship between the variables X_2 – *Delays in shipments to clients* and X_{3_Macro} – *Perception of external macro risks* (Laureano & Botelho, 2017; Marôco, 2018).

Table 5.26 – Spearman's correlation coefficient for variables X_2 – *Delays in shipments to clients* and X_{3_Macro} – *Perception of external macro risks*, in Norway

Norway			X_2 - *Delays in shipments to clients*	X_{3_Macro} – *Perception of external macro risks*
Spearman's Rho	X_2 - *Delays in shipments to clients*	Correlation Coefficient	1	-,046
		Sig. (2-tailed)	.	,727
		N	71	60
	X_{3_Macro} – *Perception of external macro risks*	Correlation Coefficient	-,046	1
		Sig. (2-tailed)	,727	.
		N	60	76

Therefore, the decision is the rejection of H2.3, as this data indicates that there is no correlation among the perception of external risk factors and delays in shipments to clients in Norway. Furthermore, the correlational analysis indicates a clear difference between the association between the perception of external macro risks and the perception of external micro risks with the delays in shipments to clients, in Norway.

5.2.7 H3.1 - *The delays in receivements from suppliers* are *positively associated with delays in shipments to clients in both countries*

The correlation analysis of the variables X_1 - – D*elays in receivements from suppliers* and X_2 – *Delays in shipments to clients,* is illustrated in Table 5.27, with a corelation coefficient of 0,156 and a sig value of 0,115, pinpointing to a positive, non-significant and weak link between the two variables (Laureano & Botelho, 2017; Marôco, 2018).

Table 5.27 – Spearman's correlation coefficient for variables X_1- D*elays in receivements from suppliers* and X_2 – *Delays in shipments to clients,* in both countries

Portugal and Norway			*X_1- Delays in receivements from suppliers*	*X_2 – Delays in shipments to clients*
Spearman's Rho	*X_1- Delays in receivements from suppliers*	Correlation Coefficient	1	,156
		Sig. (2-tailed)	.	,115
		N	127	103
	X_2 – Delays in shipments to clients	Correlation Coefficient	,156	1
		Sig. (2-tailed)	,115	.
		N	103	114

The rejection of H3.1 is the decision; nonetheless, this analysis shows that there is a slight positive relationship between the delays in receivements from suppliers and the delays in shipments to clients in both countries.

5.2.8 H3.2 - *The delays in receivements from suppliers are positively associated with delays in shipments to clients in Portugal*

The correlation analysis lead to a positive, weak and non-significant association between the variables X_1- D*elays in receivements from suppliers* and X_2 *– Delays in shipments to clients*, as the correlation coefficient is 0,132 and the *sig* value is equal to 0,431 (Laureano & Botelho, 2017; Marôco, 2018), as noticed in Table 5.28.

Table 5.28 – Spearman's correlation coefficient for variables X_1- D*elays in receivements from suppliers* and X_2 *– Delays in shipments to clients*, in Portugal

Portugal			X_1- D*elays in receivements from suppliers*	X_2 *– Delays in shipments to clients*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,155
		Sig. (2-tailed)	.	,352
		N	48	38
	X_2 *– Delays in shipments to clients*	Correlation Coefficient	,155	1
		Sig. (2-tailed)	,352	.
		N	38	43

Furthermore, the decision is the rejection of H3.2 – however, this evidence reveals a mildly positive association between the delays in receivements from suppliers and the shipments to clients in Portugal.

5.2.9 H3.3 - *The delays in receivements from suppliers are positively associated with delays in shipments to clients in Norway*

The correlation coefficient for X_1- D*elays in receivements from suppliers* and X_2 *– Delays in shipments to clients* is equal to 0,156 and the sig value corresponds to 0,214, as revealed in Table 5.29. This correlation analysis results in weak, non-significant, positive correlation between the variable (Laureano & Botelho, 2017; Marôco, 2018),

Table 5.29 – Spearman's correlation coefficient for variables X_1- D*elays in receivements from suppliers* and X_2 – *Delays in shipments to clients*, in Norway

Norway			X_1- D*elays in receivements from suppliers*	X_2 – *Delays in shipments to clients*
Spearman's Rho	X_1- D*elays in receivements from suppliers*	Correlation Coefficient	1	,149
		Sig. (2-tailed)	.	,235
		N	79	65
	X_2 – *Delays in shipments to clients*	Correlation Coefficient	,149	1
		Sig. (2-tailed)	,235	.
		N	65	71

The decision is the rejection of H3.3. Nonetheless, these results suggest that there is a slight positive, yet non-significant, relationship between delays in receivements from suppliers and delays in shipments to clients in Norway.

5.3 Discussion of the Results

Throughout this chapter, a study on the possible associations between delays in receivements of suppliers, delays in shipments to clients and perception of external risk is conducted, resorting to the statistical analysis of five composite variables. Table 5.30 compiles the decisions of the hypotheses of this research.

Table 5.30 - Summary of the hypotheses' decisions

H1.1.	Rejection
H1.2	Rejection
H1.3	Rejection
H2.1	Partial rejection
H2.2	Partial rejection
H2.3	Rejection
H3.1	Rejection
H3.2	Rejection
H3.3	Rejection

The first hypothesis concerns the delays in receivements from suppliers and perception of external risk in the supply chain. The analysis of the data concerning both countries resulted in a higher correlation coefficient when considering global external risk, and macro external risk. As far as the data from Portuguese companies, the results were similar, and the association between the delays in receivements and micro external risk were significant when considering a sig value of 0,06. However, Norwegian companies provided answers that resulted in extremely low correlation coefficients for these two variables. This difference in results may be linked to the differences in the perception of risk when two different countries are considered - Weber et al. (1998) states that the national culture justifies the different perceptions in supply chain risk. Wagner et al. (2008) also found differences among risk perception in companies from Germany and the USA. Eventually due to higher geographic isolation of Norwegian companies, their perception of macro and micro risk does not seem to be different; in Portugal, the micro risks show to be more present than the macro risks in terms of their association with delays in receivements from suppliers, which might result from a somewhat distancing from macro risks and a higher focus on the immediate reality.

The second hypothesis refers to the perception of external risk factors and the delays in shipments to clients. These results also suggest a higher correlation amidst these two variables for Portuguese companies, especially when considering only micro supply chain risks. Once more, these risks seem to carry higher disruptive potential. Ho et al. (2015) considered that, in general, macro risks usually carry higher negative impact on the firms, making this an unexpected result. Nonetheless, these results may occur as micro risks (suppliers' bankruptcies and strikes, transport issues and restrictions on imports/exports) arise "closer" to the focal firm, as opposed to macro risks (natural disasters, armed conflicts, terrorism and unstable political circumstances), and thereby, are possibly perceived as having a higher association in the company's ability to fulfil customer's orders.

The third hypothesis considers the link between delays in receivements from suppliers and delays in shipments to clients. Despite the correlation coefficient being positive when considering the three scenarios (both countries, Portugal and Norway), none of the correlations were significant nor strong. There were no substantial differences in the analysis of the hypotheses for this group, showing that the companies in the considered sample have similar perceptions of their ability to overcome eventual delays in receivements and preventing them from leading to delays in their own shipments to their customers. These results may be related to the fact that the firms that constitute the sample use, in majority (over 70%), a make-to-order

manufacturing process, which means that the firms need to have stock prior to customer orders; thereby, the occurrence of upstream delays may not be reflected in downstream delays.
Overall, the correlation coefficients calculated for companies in Norway are significantly lower than the ones concerning Portuguese firms. This disparity may be explained by the difference in weather (NationMaster, 2020), that might influence transport networks (Rietveld, 2013). Husdal and Bråthen (2010) stated in their research that Norwegian companies had implemented mitigation measures, such as safety stock, and thereby, transportation disruptions, which could lead to delays from suppliers, did not represent a major concern for companies.

CHAPTER 6

Conclusions

This chapter outlines the key findings of this study. The research questions will be answered and the accomplishment of the objectives proposed in Chapter 1 will be analysed. Afterwards, the limitations of this research will be presented, and the suggestions for future research will be made.

6.1 Answers to the Research Questions

RQ1: Is the risk from external factors associated with delays in receivements from suppliers?

The first research question is concerned with H1.1, H1.2 and H1.3. Through the analysis undertaken in the previous chapter, all these hypotheses were rejected, pointing to a non-significant nor strong association between the perception of external risk factors and the delays in receivements from suppliers. However, a substantial difference among countries was found – Portugal appears to perceive micro risks as more correlated with delays in the receivements from suppliers.

The first objective, defined as "Determine if there is an association between delays in receivements from suppliers and the way external risk factors are perceived" was considered to be achieved, in the sense that no statistically significant correlations were found within the scope of the sample to prove that external factors are associated with delays in receivements from suppliers

RQ2: Is the risk from external factors associated with delays in shipments to clients?

This research question is linked to hypotheses H2.1, H2.2 and H2.3.Concerning the first two, they were partially rejected. Once more, higher correlations were found when considering Portuguese firms in the matter of micro risks versus macro risks, in regards of their correlation with delays in receivements from suppliers, which could arise from a perceived distance from macro risks, that may be concerned with a greater emphasis on the more proximate reality from the focal company.

The second objective, established as "Determine if there is an association between delays in shipments to clients and the way external risk factors are perceived", is viewed as being accomplished, as it is possible to affirm, within the scope of the sample, that external global and micro risk factors are positively associated with delays in shipments to clients, when considering both countries and Portugal.

RQ3: Are the delays in receivements from suppliers associated with delays in shipments to clients?

The third research question is connected to H3.1, H3.2 and H3.3. The findings of this research point to the existence of a slight positive, yet weak and non-significant association, within the scope of the sample, between the delays in receivements from suppliers and the delays in shipments to clients, with no significant differences among countries, demonstrating that the firms reviewed in this study have common perceptions of their efforts to handle potential delays in receivements from suppliers and avoid delays in shipments to their own clients.

The third objective, identified as "Determine if there is an association between delays in receivements from suppliers and delays in shipments to clients" is, thereupon, attained.

6.2 Limitations

The minor amount of elements in the study is one limitation of the outcomes of this research – the database only contained information regarding 145 firms (92 Norwegian companies and 43 Portuguese companies), which is not a large amount of firms nor it was possible to assess the representativity of the sample on the general population and therefore, the results are only valid under the scope of the firms that constitute the sample.

Cronbach's alpha is a measure of reliability of scales, that will increase as the average item-item correlation increases (Marôco, 2018). The value of the Cronbach's alpha coefficient for variable X_1 – *Delays in Receivements from Suppliers* is equal to 0,243, and for variable X_2 – *Delays in Shipments to Clients*, corresponds to 0,534. These values did not reflect a strong reliability among items (Laureano & Botelho, 2017), translating into an additional limitation of this research.

6.3 Suggestions for Future Research

As seen in the Context section, the latest epidemic of coronavirus (COVID-19 / SARS-CoV-2) is one of the most severe crises of the last decades, triggering the breakdown of supply chains across the world (Araz et al., 2020). A potential relevant future research may be to try to explore the disparity in the perception of external risks in the SC, as Harland et al. (2003) state that after an organisation suffers severe losses in its business, the attitude towards risks may change. Therefore, it may be relevant to investigate the answers the same companies would currently provide, as to assess the differences before and after this pandemic occurred.

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Annex

Annex A – Reliability Analysis

Annex A.1 – Item-Total Statistics for Variable X_1 – *Delays in receivements from suppliers*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{1.1}$ – *Frequency of receivements from suppliers*	7,5591	4,995	,113	,041	,204
$X_{1.2}$ – *Delivery time from the most important suppliers*	8,7087	5,430	,038	,096	,303
$X_{1.3}$ - *Frequency of rush orders made to the most important suppliers*	8,9764	4,944	,048	,066	,308
$X_{1.4}$ - *Frequency of delays from suppliers*	9,7165	5,046	,384	,154	-,046[a]

Annex A.2 – Item-Total Statistics for Variable X_2 – *Delays in shipments to clients*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{2.1}$ – *Frequency of shipments to clients*	8,2018	5,897	,509	,334	,249
$X_{2.2}$ – *Delivery time in orders sent to clients*	8,5965	7,889	,416	,329	,380
$X_{2.3}$ – *Frequency of rush orders to clients*	8,6754	5,885	,455	,209	,312
$X_{2.4}$ - *Frequency of delays in orders sent to clients*	9,7632	12,519	-,135	,094	,675

Annex A.3 – Item-Total Statistics for Variable $X_{3.1}$ – *Probability of disruption (global external risks)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{3.1.1}$ - *Probability of occurrence of natural disasters*;	15,26	16,941	,465	,387	,724
$X_{3.1.2}$ - *Probability of occurrence of armed conflicts*;	15,76	19,454	,416	,618	,737
$X_{3.1.3}$ - *Probability of occurrence of terrorism*;	15,62	18,551	,483	,518	,726
$X_{3.1.4}$ - *Probability of occurrence of unstable political circumstances*;	15,38	17,507	,486	,488	,721
$X_{3.1.5}$ - *Probability of occurrence of accidents*;	14,82	17,576	,446	,338	,728
$X_{3.1.6}$ - *Probability of occurrence of suppliers' bankruptcies*;	14,85	17,900	,378	,260	,739
$X_{3.1.7}$ - *Probability of occurrence of suppliers' strikes*;	14,92	16,385	,536	,425	,711
$X_{3.1.8}$ - *Probability of occurrence of transport issues;*	14,41	18,210	,380	,252	,738
$X_{3.1.9}$ - *Probability of occurrence of restrictions on imports/exports.*	14,84	17,477	,361	,286	,745

Annex A.4 – Item-Total Statistics for Variable Variable $X_{3.2}$ – *Financial consequences of disruption (external global risks*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{3.2.1}$ – *Financial consequences of natural disasters*;	25,79	56,512	,765	,766	,878
$X_{3.2.2}$ - *Financial consequences of armed conflicts*;	25,96	56,755	,749	,805	,879
$X_{3.2.3}$ - *Financial consequences of terrorism*;	25,99	56,567	,778	,836	,876
$X_{3.2.4}$ - *Financial consequences of unstable political circumstances*;	26,22	59,004	,744	,688	,880
$X_{3.2.5}$ - *Financial consequences of accidents*;	25,74	59,149	,715	,580	,882
$X_{3.2.6}$ - *Financial consequences of suppliers' bankruptcies*;	26,18	63,283	,500	,525	,898
$X_{3.2.7}$ - *Financial consequences of suppliers' strikes*;	26,34	63,433	,603	,639	,891
$X_{3.2.8}$ - *Financial consequences of transport issues;*	26,24	63,374	,599	,585	,891
$X_{3.2.9}$ - *Financial consequences of restrictions on imports/exports*	26,04	63,062	,509	,359	,898

Annex A.5 – Item-Total Statistics for Variable $X_{3.1\_Macro}$ – *Probability of disruption (external macro risks)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{3.1.1}$ - *Probability of occurrence of natural disasters*;	6,33	5,011	,551	,374	,700
$X_{3.1.2}$ - *Probability of occurrence of armed conflicts*;	6,81	6,416	,628	,598	,694
$X_{3.1.3}$ - *Probability of occurrence of terrorism*;	6,68	5,940	,645	,507	,674
$X_{3.1.4}$ - *Probability of occurrence of unstable political circumstances*;	6,42	5,394	,551	,434	,695
$X_{3.1.5}$ - *Probability of occurrence of accidents*;	5,88	6,042	,355	,239	,772

Annex A.6 – Item-Total Statistics for Variable Variable $X_{3.2\_Macro}$ – *Financial consequences of disruption (external macro risks)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{3.2.1}$ – *Financial consequences of natural disasters*;	13,37	22,597	,826	,727	,896
$X_{3.2.2}$ - *Financial consequences of armed conflicts*;	13,56	22,077	,849	,805	,891
$X_{3.2.3}$ - *Financial consequences of terrorism*;	13,58	22,004	,878	,831	,885
$X_{3.2.4}$ - *Financial consequences of unstable political circumstances*;	13,85	24,476	,769	,639	,907
$X_{3.2.5}$ - *Financial consequences of accidents*;	13,34	25,675	,653	,452	,928

Annex A.7 – Item-Total Statistics for Variable Variable $X_{3.1\_Micro}$ – *Probability of disruption (external micro risks)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{3.1.6}$ - *Probability of occurrence of suppliers' bankruptcies*;	6,77	5,221	,397	,230	,648
$X_{3.1.7}$ - *Probability of occurrence of suppliers' strikes*;	6,84	4,273	,605	,371	,505
$X_{3.1.8}$ - *Probability of occurrence of transport issues;*	6,31	5,089	,465	,221	,607
$X_{3.1.9}$ - *Probability of occurrence of restrictions on imports/exports.*	6,75	4,926	,380	,195	,665

Annex A.8 – Item-Total Statistics for Variable Variable $X_{3.2\_Micro}$ – *Financial consequences of disruption (external micro risks)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
$X_{3.2.6}$ - *Financial consequences of suppliers' bankruptcies*;	9,21	8,566	,545	,440	,770
$X_{3.2.7}$ - *Financial consequences of suppliers' strikes*;	9,37	8,340	,738	,619	,675
$X_{3.2.8}$ - *Financial consequences of transport issues;*	9,29	8,487	,697	,542	,695
$X_{3.2.9}$ - *Financial consequences of restrictions on imports/exports.*	9,09	9,036	,462	,288	,813

Annex B – Correlational Analysis

Annex B.1 - Kolmogorov-Smirnov tests for variables X_1, X_2, X_3, X_{3_Macro} and X_{3_Micro}

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
X_1 – *Delays in receivements from suppliers*	,099	86	,038
X_2 – *Delays in shipments to clients*	,113	86	,008
X_3 – *Perception of external global risks*	,097	86	,045
X_{3_Macro} – *Perception of external macro risks*	,145	86	,000
X_{3_Micro} - *Perception of external micro risks*	,106	86	,019