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Improving the supplier risk
management process during
COVID-19

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Management summary

Purchasing is a significant part at Company X, which, along with the rest of the world, is now facing a severe pandemic, namely, the COVID-19 crisis. Compared to other pandemics, COVID-19 has had a greater impact on the economy because of strict public health measures that are disrupting economic activities for companies and citizens. Given the partial or total lockdown measures implemented in a large part of the world, this crisis has had a major impact on international suppliers. Because the current strategy is outdated and not used properly, the current supplier risk management process needs to be improved. While the company's strategy may have been appropriate for smaller risks in the past, it has proved to be ineffective in a large-scale crisis such as COVID-19. And so, an excel list has been drawn up as a replacement, which is completed manually and a time-consuming task. As a result, high-risk suppliers were not noticed and Company X continued to work with them. This can cause a supplier to suddenly fall over without Company X ever having identified it. Therefore, the goal of this research is to improve the company's supplier risk management process so it can respond to current and future crises.

To improve this risk management strategy, research is done in the field of risk and supplier monitoring, risk management and pandemics. Data is obtained from semi-structured interviews that are carried out with employees from various departments with a close relationship to the suppliers and risk management officers. Additionally, business documentation is used regarding to the supplier risk management process, supplier monitoring and the impact of COVID-19 on the risk management process. This data will be used to answer the following research question: *How can Company X improve its supplier risk management process to be able to deal with possible pandemics such as COVID-19?*

In the supplier monitoring process, the factors, systems and communication are examined to find the best supplier monitoring strategy, revealing that delivery and quality are the most important factors in this process. These functions are measured in the enterprise resource planning (ERP) systems, Oracle and Cognos, and these results are periodically discussed with the supplier. In the supplier risk management categorisation, Company X uses the same categories as described in the theory: supplier risks, market risks and item risks. For these categories, risks are identified, but the implementation is not always carried out properly. Stricter attention must be paid to implementing the right plans. Secondly, the supplier risk management process steps are risk identification, risk assessment, risk management implementation and risk monitoring. The first step of this process, risk identification, becomes increasingly important during a pandemic. This means that

Company X needs to pay more attention to this. Additionally, Company X must pay more attention to risk monitoring. This risk monitoring can be done with the two most important Microsoft Excel documents used in this process being the PUR102 and the COVID-19 master file. These documents indicate the risk per purchase order (PO) line. But these tools are ineffective and need to be improved. The impact of COVID-19 on Company X is limited, with the delivery times of the suppliers being the most delayed because of COVID-19. This does not have a major impact on Company X because it works with stock and because its customers understand the situation.

The most important recommendations for Company X affect the two Excel documents mentioned. Firstly, Company X only monitors its suppliers on delivery time. The research has shown that quality is an important factor as well as delivery time. So the first recommendation means that Company X must monitor its suppliers on delivery time and quality, whereby it now does so only on delivery time. Secondly, the COVID-19 master file looks at the number of risky PO lines per supplier. This is done for a standard number of medium- or higher-risk PO lines but does not take into account the total number of the supplier's PO lines. This reflects poorly the ratio between the different numbers of PO lines from suppliers. It is recommended that Company X consider this impact on a percentage basis, dividing the number of medium- or higher-risk PO lines by the total number of PO lines. Finally, the PUR102 and COVID-19 master files both indicate whether a risk is mitigated. The interviews and the files reveal that this mitigation is often not followed up, which increases the risks. The final recommendation, therefore, is to plan more time for risk mitigation and to monitor this follow-up more closely.

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1 Introduction

1.1 Background to the Company X situation

The world is facing a severe pandemic, namely, the COVID-19 crisis. Compared to other pandemics, COVID-19 has had a larger impact on the economy because of strict public health measures that have disrupted economic activities for companies and citizens. As a result of the partial or total lockdown measures implemented in a large part of the world, the ability of many suppliers to provide their raw materials and products has been compromised.¹ Therefore, the supplier risk management process of Company X needs a closer look.

Before discussing the concept of supply risk management, risk management is first explained. Mehr and Hedges (1963), as stated in Crockford (1982), described risk management as “the management of those risks for which the organisation, principles and techniques appropriate to insurance management are useful” (p. 170).² The number of definitions of risk management has increased, and the process has become increasingly important for companies throughout the years.³ However, on the whole, the definition of risk management has not undergone much change. Previously, risk management was based particularly on natural disasters, but today, the definitions apply more to finances, intending to maximise firm value by cost reduction related to various risks.⁴ The risk management process consists mainly of three steps – risk identification, risk analysis and risk evaluation⁵ – but the supply chain is a key feature as well.⁶ This supply chain is the entire network of individuals and resources involved in a product, from the first manufacturer to the end-user.⁷ March and Shapira (1987) described the buyer-supplier risk as “the variation in the distribution of possible supply chain outcomes, their likelihood and their subjective values” (p. 1404).⁸ A more recent definition is provided by Peck (2006), who defined the buyer-supplier risk more broadly, namely, “anything that disrupts or impedes the information, material or product flows from original suppliers to the delivery of the final product to the ultimate end user” (p. 130).⁹

¹ See Donthu and Gustafsson (2020), p. 284.

² See Crockford (1982), p. 170.

³ See Dionne (2013), p. 150.

⁴ See Dionne (2013), p. 165.

⁵ See Kähkönen et al. (2016), p. 309.

⁶ See Sohdi (2005), p. 70.

⁷ See Benseddik (2019), p. 1.

⁸ See March and Shapira (1987), p. 1404.

⁹ See Peck (2006), p. 130.

A global crisis such as COVID-19 is characterised by three components: long-term unpredictable disruption, an outbreak in the population and disruptions in supply and demand.¹⁰ At Company X, two types of risks are differentiated. The first one is structural risk, these are the risks that equate to the cost of doing business. An example of which is the health of the economy that affects the entire industry. The second is operational risk, which is performance-oriented and is measured more frequently. Operational risks are caused by processes, people or external events. The COVID-19 crisis encompasses both structural and operational risks. It is a structural risk because of the duration of the crisis and because it affects the entire industry. Likewise, it is an operational risk because the pandemic is caused by an external event. Company X suffered from process failures involving its suppliers. For example, countries such as India and France were in lockdown, so the suppliers from those countries were closed. As a result, Company X no longer received parts from these suppliers, which created a challenge for the company. Because of this crisis, Company X immediately turned to its supplier monitoring and purchasing officers.

Such monitoring is an important part of supplier risk management and consists of two parts. First is supplier monitoring, the aim of which is to identify supplier discrepancies, such as weak financial or inventory status, at an early stage. The second type of monitoring is risk monitoring, which contains indicators for incidents that may result in disruptions for a company.¹¹ Both monitoring types are important for this research. Company X has established a crisis management team but it struggles to present a useful overview of the crisis' impact; this includes, for example, which suppliers are affected on which level, such as financial or technological, and what the impact is on different projects. The current supplier risk management process is outdated and cannot be used in a pandemic situation. And so, an excel list has been drawn up as a replacement, which is completed manually. In this list, purchasers must fill in the risk level of the supplier, which is a time-consuming task and often is not done with care. As a result, high-risk suppliers were not noticed and Company X continued to work with them. This can cause a supplier to suddenly fall over without Company X ever having identified it. In other words, the problem is that these obsolete processes are not equipped to handle this form of risk, as they rely on Excel lists that are not organised effectively.

¹⁰ See Ivanov (2020), p. 2.

¹¹ See Talet, Karadsheh, Jarrah, and Alhawari (2018), p. 80.

1.2 Aim of the research

This section introduces the aim of the research, which is to improve the supplier risk management process of Company X so it can manage crises such as the COVID-19 pandemic. The company's current strategy is outdated and insufficient; while it may have worked with smaller risks in past years, it cannot respond to a large-scale crisis. Therefore, there is significant interest in improving this risk management process.

To do so, research must be done in the field of risk and supplier monitoring, risk management and pandemics. Firstly, the supplier monitoring process is investigated, with an eye towards how suppliers are monitored by Company X to spot possible new risks. This monitoring is being performed during COVID-19, so the current working process of suppliers during this crisis is investigated. Secondly, the current and previous supplier risk management processes are examined, and the impact of COVID-19 on the risk management process is measured. Lastly, data are gathered on how Company X can improve its current risk management strategy; this is done by examining the literature. Based on this literature, a risk management framework is designed for Company X.

1.3 Academic contribution

The goal of this research is to improve the supplier risk management process so that Company X is prepared to manage a crisis such as the COVID-19 pandemic. As is known in literature, the main goal of risk assessment is to provide information about the identified risk so that its likelihood and impact can be reduced at a later stage.¹² First, the risk for Company X in this research can be stated as low probability-high impact, located in the bottom right of Figure 1, created by Hallikas et al. (2004).¹³ This because pandemics do not occur very frequently, so there is a small probability, but a pandemic such as COVID-19 can have a major impact. The strategy for managing risk in this box has not been addressed in the literature.¹⁴ Therefore, the solution for this risk management strategy is identified in this research to make an academic contribution.

Secondly, to improve the supplier risk management process, a strategy must be created that can be used for Company X during the COVID-19 crisis. Many researchers have defined various supplier risk management strategies, but these types of plans are not one-size-fits-all. Therefore, it is interesting to compare these supplier risk management strategies

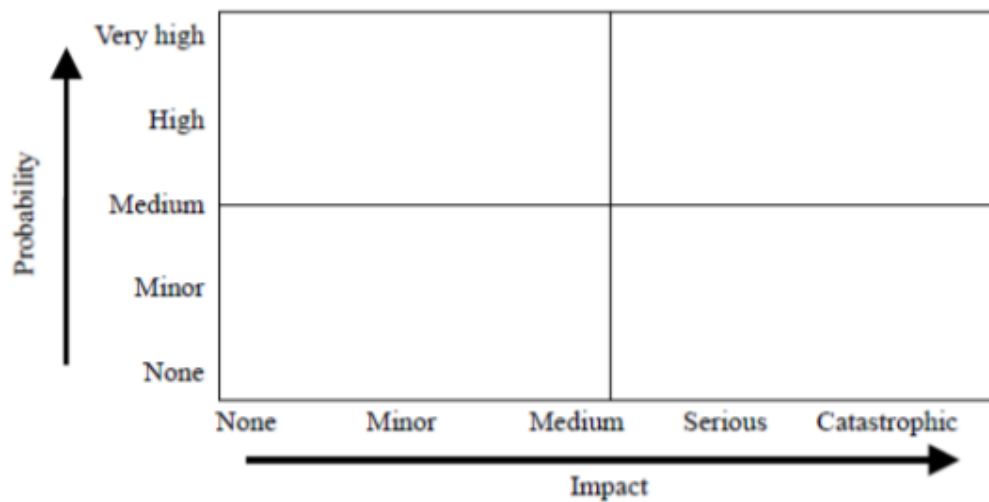
¹² See Kern et al. (2012), p. 65.

¹³ See Hallikas et al. (2004), p. 53.

¹⁴ See Hallikas et al. (2004), p. 53.

and create a new strategy for Company X to manage the current COVID-19 crisis. This new strategy may work for other similar companies as well in times of disaster, and, as a result, can make a second academic contribution.

Figure 1: **Risk diagram**



Source: Hallikas et al. (2004, p. 53)

1.4 Research questions

Now that the problem and aim of this research are described, this information is translated into several research questions to provide a clear structure for this study. The following main research question is formulated:

Research question: How can Company X improve its supplier risk management process to be able to deal with possible pandemics such as COVID-19?

To answer the main research questions, the following sub-questions are stated:

- What are the current processes to monitor the supplier?
- What does the current supplier risk management process look like?
- What is the impact of COVID-19 on the risk management process?

To provide an answer to the research questions, this paper is organised as follows: Chapter 2 describes the theoretical framework with models that are relevant for this research while Chapter 3 presents the methodology in which the research method is formulated. Chapter 4 provides the final results using tables and other relevant data, and Chapter 5 includes the discussion and conclusion.

2 Literature review

2.1 An outline of the literature review

The first part of this literature review explains the field of supplier monitoring in combination with supply risk management. Second is the increased interest in supply risk management as an introduction to the research topic. Thirdly, the term “supply risk” is defined. Next, the categorisation of risk is provided, and the most important categories are mentioned. After this, the process of supplier risk management is explained, including the four main components of this term. Then, more information about COVID-19 is provided. After this, propositions about the research are formulated. In the end, a conclusion for this literature review is stated in which the relevance of theory for the research company is investigated.

2.2 Monitoring suppliers

Supplier monitoring is one of the main tasks assigned to purchasing managers of companies and can be defined as the evaluation process that examines all pieces in the supply chain of a company.¹⁵ Monitoring suppliers is important for maintaining an effective relationship between the company and the supplier and can include variables such as quality, process capability, innovation and lead time.¹⁶ During monitoring, the capability of the supplier is observed, which helps identify any deficits at an early stage.¹⁷ Suraraksa and Shin (2019) stated that the variable of the price is the most important factor, both for selecting and monitoring a supplier.¹⁸ However, Talluri and Sarkis (2002) stated that more factors – such as quality, delivery and flexibility – must be taken into account.¹⁹ Ittner, Larcker, Nagar and Rajan (1999) found that the process of supplier monitoring can increase profitability, product quality and supplier performance.²⁰ Monitoring the supplier is especially important in the case of a relationship based on high uncertainty because it is fraught with a greater chance of risks.²¹

Three approaches are stated in the literature that must be considered as part of the monitoring process: a quantitative rating system, performance reviews and communication and development of the partnership (Asmus & Griffin, 1993; Schorr, 1998; Talluri & Sarkis,

¹⁵ See Talluri and Sarkis (2002), p. 4257.

¹⁶ See Suraraksa and Shin (2019), p. 4.

¹⁷ See Akamp and Müller (2013), p. 56.

¹⁸ See Suraraksa and Shin (2019), p. 3.

¹⁹ See Talluri and Sarkis (2002), p. 4257.

²⁰ See Ittner et al. (1999), p. 276.

²¹ See Akamp and Müller (2013), p. 56.

2002). Within this process, the purchaser must monitor tangible factors – such as cash, equipment and buildings – and intangible factors – such as goodwill or trademarks.²²

For this research, Company X must monitor its suppliers on variables such as price, quality, process capability, innovation, lead time, delivery and flexibility, especially in a highly uncertain relationship. This can be done with a quantitative rating system, performance reviews and communication and development of the partnership.

2.3 Increased interest in supply risk management

In recent years, the unpredictability of the customer's buying behaviour has increased, as has the demand for changes in new fields of technology.²³ Both result in a higher possibility for potential supply risk.²⁴ Furthermore, business trends these days indicate a growing interest in outsourcing, decreasing the number of suppliers and improving lead times. However, these changes can result in a greater chance of risk in the supply chain.²⁵ For this reason, Tang (2006) stated that supply chain risk management is necessary for today's companies,²⁶ which find themselves dependent on suppliers. This dependence requires more attention to supplier selection by the purchasing manager and is explained later in this chapter.²⁷ Purchasing managers especially become more aware of supplier delays, supply distortions and supply failures. Jüttner (2005) stated that managers need support from literature to develop a strategy to appropriately manage these risks.²⁸ For this reason, available literature on supply risk management has increased in recent years.²⁹

2.4 Defining (supply) risk

There are many definitions of the term "risk", with most focussing on the negative impact of actions. Bernstein (1998) explains that the word originates from the Latin word "risicare", which means "to dare". This definition indicates the likelihood of choosing a certain reaction.³⁰ Holton (2004) describes a more general definition of risk in which exposure and uncertainty are the main components, namely, "exposure to a proposition of which one is

²² See Talluri and Sarkis (2002), p. 4258.

²³ See Gualandris and Kalchschmidt (2015), p. 459.

²⁴ See Gualandris and Kalchschmidt (2015), p. 459.

²⁵ See Ganguly and Bandyopdhyay (2018), p. 1160.

²⁶ See Tang (2006), p. 34.

²⁷ See Ganguly and Bandyopdhyay (2018), p. 1161.

²⁸ See Jüttner (2005), p. 121.

²⁹ See Gualandris and Kalchschmidt (2015), p. 460.

³⁰ See Bernstein (1998)

uncertain” (p. 22).³¹ A tool that can be used for measuring risk is the risk matrix, which is stated in Figure 2. Within this matrix, a distinction is made between the probability of occurrence and the severity of the consequences. The axis has deviated within five categories, at which a higher number indicates a higher probability or severity. For example, risks that have a high probability are placed on the left side and risks with almost no probability are placed on the right side. Within this matrix, three zones of risk are separated. The first is the black zone, which includes catastrophic risks; the second is the grey zone, which indicates moderate risks; and the third is the white zone, which includes lower and acceptable risks.³²

Figure 2: **Risk matrix**

		Probability of Occurrence				
		5	4	3	2	1
Severity of Consequences	5					1
	4		2			
	3			3		
	2					
	1					

Source: Chakrabarty, Mannan, and Cagin (2016, p. 14)

Supply risk can have an especially high impact on a company’s profitability.³³ Zsidisin (2003) defined the supply risk as “the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety” (p. 222).³⁴ For this research, the risk for Company X can be located in the risk matrix of Figure 2. As previously discussed, the probability of occurrence for a large disaster such as COVID-19 is very low. Therefore, the risk can be placed on the right side of the matrix at a scale of 1. Within this risk, the consequences for the economy and Company X can be quite high, which means it can be placed at the top of

³¹ See Holton (2004), p. 22.

³² See Chakrabarty et al. (2016), p. 13.

³³ See Kähkönen et al. (2016), p. 315.

³⁴ See Zsidisin (2003), p. 222.

the matrix at a scale of 4 or 5. This indicates that the risk for Company X is located in the black zone, which means catastrophic risks, or in the top of the grey zone, which means moderate risks. Later in this research, the exact impact of COVID-19 on Company X will be investigated, but for both categories, the risk needs to be mitigated.

Cavinato (2004) stated that the supply chain consists of five sub-chains: physical, financial, informational, relational and innovational. Therefore, supply risk must be recognised in all of these factors by monitoring these elements.³⁵ How a company anticipates on these elements is important for the company's product characteristics, such as value, quality, price and performance. When the company does not correctly apply this anticipation, it can be harmful to the company in terms of image and brand value.³⁶ For Company X it means that the risks must be identified by the company itself, but the management of risks is different for each company.³⁷ This risk management topic is discussed in Chapter 2.6 of this research.

2.5 Supply risk categorisation

When estimating the risk of an organisation, it is helpful to categorise the various types of risks it faces. Understanding the categorisation of risks can help procurement employees determine their impact on the company's supply strategy. However, literature explains that it is difficult to classify supply risks in just one way because the types of risks are different for each type of purchase and its industry.³⁸ Supply risk is divided into three main categories – supplier risk, market risk and item risk – and two of these categories also include sub-categories. These risk categories are discussed by multiple authors, as indicated in Appendix 1. This categorisation can be helpful for risk management officers to determine which risk they are facing and to identify the most appropriate strategy to manage it. The sub-categories of supplier risk consist of environmental, financial, operational and strategic.³⁹ Next, item risk is divided into two categories, namely, impact on profitability and nature of product application.⁴⁰ The distribution of the divisions that will be used in this research is illustrated in Figure 3.

³⁵ See Cavinato (2004), p. 384.

³⁶ See Chen and Chang (2012), p.503.

³⁷ See Ganguly and Bandyopdhyay (2018), p. 1161.

³⁸ See Zsidisin (2003), p. 20.

³⁹ See Hoffmann (2011), p. 51.

⁴⁰ See Zsidisin (2003), p. 17.

Figure 3: **Supply risk categorisation**



Source: Invented by author

2.5.1 Supplier risk

2.5.1.1 Environmental risk

Environmental risk includes all of the uncertainties that arise from interactions in the supply chain environment.⁴¹ These events – which can be a result of accidents, socio-political actions or climatic conditions – can have a damaging effect on the purchasing firm.⁴² Within environmental risk, there are also two sub-categories, namely, organisational risks and network-related risks. Organisational risks are those within the supplier’s organisation, such as labour or production uncertainties and information technology (IT) system failures at the supplier. Jüttner, Peck, and Christopher (2003) stated that network-related risks “arise from interactions between organisations within the supply chain” (p. 208).⁴³ The relationships among these three categories are represented in Figure 4. To summarise, environmental risk affects all companies in their market, independent of the quality of the buyer-supplier relationship.⁴⁴

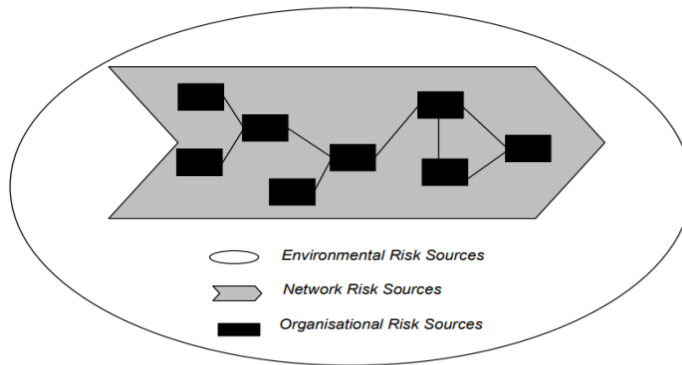
⁴¹ See Jüttner et al. (2003), p. 208.

⁴² See Schoenherr (2008), p.105.

⁴³ See Jüttner et al. (2003), p. 208.

⁴⁴ See Hoffmann (2011), p. 51.

Figure 4: Risks sources in the supply chain



Source: Jüttner et al. (2003, p. 207)

2.5.1.2 Financial risk

Financial risks are cases of financial instability or failures of suppliers. The risk in the buyer-supplier situation can be a consequence of supplier default, insolvency or bankruptcy. The risk affects the buyer-supplier relation and has no impact on the total market.⁴⁵ Giunipero and Eltantawy (2004) state that the financial stability of the supplier becomes increasingly important because of the increased dependency on outsourced suppliers. If these suppliers are financially unstable, the risk increases.⁴⁶ This is especially the case when there are few or no alternative suppliers. For this reason, it is necessary to verify the financial health of suppliers.⁴⁷ There are a few ways in which to do so, including measuring the payment behaviour of the supplier and assessing the supplier's financial data, such as the equity ratio or other debts.⁴⁸

2.5.1.3 Operational risk

Chowdhury, Lau and Pittayachawan (2019) described operational supply risk as “the manifestation of variations in expected outcomes of the upstream supply chain” (p. 478).⁴⁹ Zsidisin (2003) defined six categories of operational risk: “capacity constraints, inability to reduce costs, incompatible information systems, quality problems, unpredictable cycle times and volume and mix requirement changes” (p.18).⁵⁰ Schoenherr, Rao Tummala and Harrison (2008) described operational risks differently, saying they occur when suppliers are unable to fulfil the buyer's requirements. They defined the following terms: on-time and on-budget

⁴⁵ See Wagner and Bode (2008), p. 308.

⁴⁶ See Giunipero and Eltantawy (2004), p. 701.

⁴⁷ See Zsidisin et al. (2008), p. 415.

⁴⁸ See Hoffmann (2011), p. 62.

⁴⁹ See Chowdhury et al. (2019), p.478.

⁵⁰ See Zsidisin (2003), p. 18.

delivery, order fulfilment risk, engineering and innovation capability and supplier's supplier management.⁵¹ To summarise, all of these risks describe situations in which the supplier is unable to produce and deliver according to the buyer's demand.

2.5.1.4 Strategic risk

According to the previous operational risk, a supplier is unable to fulfil the buyer's requirements. With strategic risk, the supplier can fulfil the requirements but is unwilling to do so.⁵² The risk arises from a weak collaboration between the buyer and the supplier and the risk of a supplier acting as a competitor.⁵³ In this case, the buyer seeks to be a preferred customer, but the buyer is not attractive for the supplier. Steinle and Schiele (2008) stated that "a firm has preferred customer status with a supplier, if the supplier offers the buyer preferential resource allocation" (p. 11). However, the purchasing organisation can also be too dependent on a single supplier; this is called a lock-in effect. This is also a strategic risk in the buyer-supplier relationship.⁵⁴ In short, the earlier-mentioned risks impact all relationships of a supplier, while the strategic risks differ for every relationship between a buyer and supplier.

2.5.2 Market risk

In the previous paragraphs, researchers discussed only supplier risk (Hoffmann, 2011; Jüttner et al., 2003; Wagner & Bode, 2008; Giunipero & Eltantawy, 2004; Chowdhury et al., 2019; Schoenherr, 2008; Neiger, Rotaru & Churilov, 2009). However, within supply risk, two more categories can be interesting for this research. The distribution of risks is also indicated in Figure 3.

The first category is market risk. Zsidisin (2003) divided market risk into the following four categories: global sourcing, market capacity constraints, market price increase and the number of qualified suppliers.⁵⁵ Firstly, global sourcing is growing more popular, primarily to help companies lower their costs and provide access to products that are not available in their home countries. However, global sourcing does not come without risks, the greatest of which are currency fluctuations, long-term cost savings, natural

⁵¹ See Schoenherr (2008), p.104.

⁵² See Hoffmann (2011), p. 52.

⁵³ See Neiger et al. (2009), p. 158.

⁵⁴ See Wagner and Bode (2008), p. 311.

⁵⁵ See Zsidisin (2003), p. 18.

disasters and transit times.⁵⁶ Secondly, the risk of market capacity constraints occurs when only a few sources are available.⁵⁷ Thirdly, the market price can become a risk for the buyer; for example, when higher prices cause increasing procurement costs that finally translate to lower profits for the company. Lastly, the number of qualified suppliers can be risky when that number is low due to lack of capabilities or certifications.⁵⁸ These risks must be taken into account when measuring supplier risk.

2.5.3 Item risks

The last supply risk, item risk, is discussed by Zsidisin (2003) and includes two main factors: impact on profitability and nature of product application.⁵⁹ These are described below.

Impact on profitability

Various factors or item risks can have an impact on profitability, with one of the primary ones being the unavailability of products.⁶⁰ When a company cannot purchase a part or product from a supplier due to its unavailability, it cannot sell its product as well. High unavailability also leads to elevated prices charged by suppliers, leading to inflated prices for the buyer's final product as well.

Nature of product application

Research by Zsidisin (2003) indicated that the nature of a part in the product application can cause risks and that parts for a new product are at greater risk than parts for existing products. This because less is known about new product development. Therefore, companies spend more time understanding it to manage it correctly.⁶¹

2.5.4 Risk categorisation framework by Zsidisin (2003)

As stated in Chapter 2.5, supply risk can be divided into three categories: supplier, market and item characteristics. Zsidisin stated that supply managers can use these categories as a base for the development of a risk assessment tool.⁶² Within this assessment, supplier selection and evaluation play an important role and exert a long-term impact. This evaluation

⁵⁶ See Min (1994), p. 26 and Kelle and Miller (2001), p. 411.

⁵⁷ See Zsidisin (2003), p. 18.

⁵⁸ See Zsidisin (2003), p. 18.

⁵⁹ See Zsidisin (2003), p. 18.

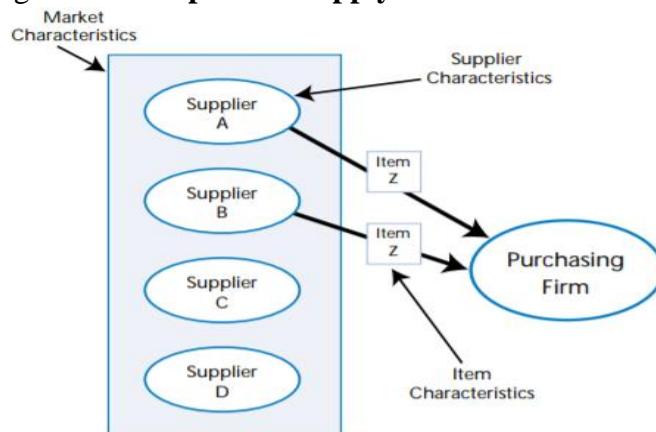
⁶⁰ See Zsidisin (2003), p. 17.

⁶¹ See Zsidisin (2003), p. 17.

⁶² See Zsidisin (2003), p. 21.

can be completed after the supplier is monitored. To clarify, overall risks can be reduced by selecting a low-risk supplier selected based on an evaluation. The three categories of risk are indicated in Figure 5, which illustrates the links between the purchasing firm and the supplier as well as the risks surrounding them. Managers can create a risk strategy based on this model.⁶³

Figure 5: Perception of supply risk



Source: Zsidisin (2003, p. 22)

2.5.5 Supply risk categorisation for Company X

Company X must categorise its risk based on the framework for managing supply risks discussed in the previous section. Within this framework, management can evaluate the risks posed by the supplier, the market and the items by examining several characteristics. A sample overview of supply risk characteristics is provided in Appendix 2. These characteristics create a better understanding of what influences supply risks and their impacts. Zsidisin (2003) offered the following example: “If a risk is perceived from a supplier firm due to quality problems, the purchasing organisation can take proactive steps such as engaging in supplier development to help eliminate those quality issues and thereby reduce the risk inherent with that supply source” (p. 20).⁶⁴ Additionally, a tool can be used to manage these risks, such as a supply risk assessment tool or a supplier evaluation or selection tool.⁶⁵ The supplier risk management process that can assist Company X is further discussed in Chapter 2.6.

⁶³ See Zsidisin (2003), p. 21.

⁶⁴ See Zsidisin (2003), p. 20.

⁶⁵ See Zsidisin (2003), p. 20.

2.6 Supplier risk management

Researchers have divided the risk management process into a variety of components, suggesting that it can be useful in a buyer-supplier relationship to share risk management knowledge so that both parties can benefit. Various frameworks provided by researchers are described in Appendix 3, and their main components – risk identification, risk assessment, risk management implementation and risk monitoring – are compared in Appendix 4. These four components that will be used in this research are represented in Figure 6 and discussed in detail in this section.

Figure 6: **Supplier risk management components**



Source: Invented by author

Risk identification

The identification of risks is fundamental because every company faces risks, but they differ for each case. The main goal of this phase is to identify future uncertainties and to be able to manage these.⁶⁶ The identification of risks activates further risk management activity;⁶⁷ in other words, the knowledge of potential risks is important, because, without this knowledge, the appropriate strategy cannot be applied. There are a variety of risks, and the buyer must select the one for which the supplier will be assessed.⁶⁸ Hallikas et al. (2004) categorised these risks for identification into “inappropriate demand, fulfilling customer deliveries, cost management and pricing, and weaknesses in resources, development and flexibility” (p. 51).⁶⁹ Within these factors, a checklist can be made to identify risks, with the goal of the checklist being to suggest questions, recognise philosophies and question trends.⁷⁰

Regarding risk identification in a supplier relationship, dependencies of the other organisation must be taken into account. A dependency is a relationship that cannot be completed until another task has begun or is completed. Factors such as quality failures and delivery failures are examples of risks in production, but many of these dependency risks are

⁶⁶ See Hallikas et al. (2004), p. 52.

⁶⁷ See Kern, Moser, Hartmann, and Moder (2012), p. 63.

⁶⁸ See Matook et al. (2009), p. 247.

⁶⁹ See Hallikas et al. (2004), p. 51.

⁷⁰ See Hallikas et al. (2004), p. 51.

difficult to identify. On the whole, information-sharing in a relationship is critical to decreasing uncertainty and lowering risks.⁷¹

Risk assessment

The assessment of risks is executed in the second phase. The main goal of risk assessment is to provide information about the identified risk so that its likelihood and impact can be reduced at a later stage.⁷² Risk assessment is necessary before devising the appropriate risk management strategy, and managers must understand how to evaluate these risks. Within this assessment, the risks from the first phase are measured and rated. There are several rating methods, but, overall, the rating must be easy to understand, easy to implement and low in cost.⁷³ Yates and Stone (1992) stated that supplier risk assessment is all about potential losses. Within these potential losses, there are five factors: establishing, identifying, understanding, assigning and appraising.⁷⁴ The impact of the risk can have material consequences for the company, such as financial costs, and non-material consequences, such as trust and reputation. These last-mentioned non-material losses can eventually cause material losses as well, and both types of losses can lead to a break in the relationship.⁷⁵

Kern, Moser, Hartmann and Moder (2012) stated that risk can be assessed by classifying all identified risks and ordering them regarding where, when and with what likelihood and impact they might occur.⁷⁶ Furthermore, Muralidharan, Antharaman and Deshmukh (2002) identified nine methods for assessing a supplier.⁷⁷ Matook, Lasch and Tamaschke (2009) reviewed these methods and selected the three best based on understanding, implementation and cost.⁷⁸ First is the categorical method, which can be used for quantitative and qualitative evaluation. The limitations of this method are subjectivity and the need for equal-weighted data. Second is the weighted point plan, which includes all weights but is subjective as well. The last method is the analytic hierarchy process, which assesses tangible and intangible factors but is useful only when measuring fewer than 20

⁷¹ See Hallikas et al. (2004), p. 52.

⁷² See Kern et al. (2012), p. 65.

⁷³ See Matook et al. (2009), p. 247

⁷⁴ See Yates and Stone (1992), p. 4.

⁷⁵ See Hallikas et al. (2004), p. 53.

⁷⁶ See Kern et al. (2012), p. 65.

⁷⁷ See Muralidharan et al. (2002), p. 24.

⁷⁸ See Matook et al. (2009), p. 247.

factors. Matook et al. (2009) stated that this method is the best based on the factors of understanding, implementation and cost.⁷⁹

Risk management implementation

In this third phase, a strategy to manage the risk can be devised using the information collected in the previous two stages. Hallikas et al. (2004) described a strategy that consists of five parts:⁸⁰ (1) risk transfer from the first person or company to another; (2) risk-taking, or carrying out a certain action with risk to achieve the desired result; (3) risk elimination, or controlling it by removing the risks that can be reduced easily; (4) risk reduction, by limiting the likelihood of the risk and reducing its impact; and (5) further analysis of individual risks, which identifies potential new risks.⁸¹ Within risk management, some risks can be reduced by the company itself but others need to be reduced jointly by the partner companies. This second tactic can be difficult if the companies have conflicting interests.⁸² Overall, it is important for companies to determine which risk they are facing and to identify a risk management strategy that they can share and that balance the risks in the relationship.

Risk monitoring

The last stage, risk monitoring, is defined by Beck, Drennan and Higgins (2002) as an indicator of an organisation's capacity for managing incidents that may result in business disruptions. This is done by implementing risk identification and control measures that can help minimise the probability and severity of possible financial and reputational losses from such an incident.⁸³ Hoffmann, Schiele and Krabbendam (2013) stated that supply risk monitoring is a necessary phase in the risk management process because it can provide a warning at an early stage when risk is discovered.⁸⁴

Compared with the previous three stages, little research has been done on this fourth stage, with previous studies largely focussing on categorising and assessing risk for supplier risk management.⁸⁵ When monitoring the risk management strategy, possible new risks can appear, and these changes can be monitored by fluctuations in customer needs, the network

⁷⁹ See Matook et al. (2009), p. 247.

⁸⁰ See Hallikas et al. (2004), p. 54.

⁸¹ See Hallikas et al. (2004), p. 54.

⁸² See Hallikas et al. (2004), p. 54.

⁸³ See Beck et al. (2002), p. 7.

⁸⁴ See Hoffmann et al. (2013), p. 202.

⁸⁵ See Blackhurst et al. (2008), p. 146.

and technology.⁸⁶ Hoffmann et al. (2013) defined risk monitoring as “the use of indicators for regularly assessing probabilities of risk occurrence” (p. 202).⁸⁷ Finally, the companies that are appropriately monitoring their risks suffer less danger from a new, uncertain movement, because they are aware of the problem at an early stage because of their risk-monitoring strategy.⁸⁸ Matook et al. (2009) stated that the goal of this phase is to reduce final risks and ensure short- and long-term relations between the supplier and the purchasing company.⁸⁹ A different risk monitoring strategy is used by Harland, Brenchley and Walker (2003), with theirs restarting the entire risk management process to identify new challenges and provide an up-to-date strategy.⁹⁰ Kern et al. (2012) confirm the importance of this step and stated that continuous improvement by monitoring is necessary to identify new risks and renew the process.⁹¹

2.6.1 Supplier risk management strategy for Company X

Based on various literature, the main components that must be used in the supplier risk management strategy are risk identification, risk assessment, risk management implementation and risk monitoring (Blackhurst et al., 2008; Hallikas et al., 2004; Matook et al., 2009; Harland et al., 2003; Kern et al., 2012). For this research, these components are investigated for Company X as they relate to their current supplier risk management process. When these components are not present in the process, or when there is space for improvement, the supplier risk management strategy will be updated.

Lastly, there are several solutions and implementation criteria with which the supplier risk management strategy must comply. For choosing the right solution, three criteria have been drawn up by Heerkens and Van Winden (2012). First, effectiveness, the problem must be solved as well as possible. Then comes efficiency, which is about getting the maximum yield. The last criterion is risk; the lowest possible risk must be chosen.⁹² Next, Obeidat, Al-Hadidi, Tarhini and Masadeh (2017) defined four operational process factors that are important for successful implementation:⁹³ (1) communication, to coordinate activities that ensure successful strategy implementation;⁹⁴ (2) operational planning of

⁸⁶ See Hallikas et al. (2004), p. 54.

⁸⁷ See Hoffmann et al. (2013), p. 202.

⁸⁸ See Hoffmann et al. (2013), p. 203.

⁸⁹ See Matook et al. (2009), p. 250

⁹⁰ See Harland et al. (2003), p. 56.

⁹¹ See Kern et al. (2012), p. 66.

⁹² See Heerkens and Van Winden (2012), p. 84.

⁹³ See Obeidat et al. (2017), p. 386.

⁹⁴ See Obeidat et al. (2017), p. 390.

strategic goals and objectives; (3) skilled employees carrying out the right tasks; and (4) control and feedback, which monitors the entire strategy implementation.⁹⁵ Company X must use these criteria when implementing the final improved supply risk management strategy.

2.7 COVID-19

As mentioned in the introduction, COVID-19 affected Company X when its suppliers were forced to halt production because of lockdowns ordered by health officials. Consequently, the company had to search for other suppliers or was forced to wait for the current suppliers to follow through with their deliveries. Company X is considering working with multiple suppliers in different countries, thereby spreading out the risk if one of these suppliers goes bankrupt or cannot deliver. In other words, because of COVID-19, Company X has been required to change its supplier risk management strategy. Improvement of this strategy is the goal of this research. To achieve this goal, information must first be obtained about COVID-19.

Outbreaks of diseases across international borders, known as pandemics, have been a source of fear throughout human history. The question is not whether there will be a new outbreak, but when and where that outbreak will occur. This is a result of the emergence of new virus sub-types from virus reassortment. Additionally, a growing global population and the increasing mixing of people and animals raises the chance of virus transfer.⁹⁶ The current global pandemic is a coronavirus known as COVID-19 that originated in Wuhan, China, and spread quickly to the rest of the world.⁹⁷ This is an exceptional and extraordinary disaster that has affected the economy on a large scale. A pandemic disaster is exceptional because it tends to start small but scales quickly.

An epidemic outbreak such as COVID-19 is characterised by three components: long-term unpredictable disruption, outbreaks in many populations and disruptions in supply and demand.⁹⁸ This crisis affects many company departments – such as sales, purchasing and the supply chain – with the global supply chain being most at risk as a result of lockdowns all over the world. Therefore, companies are unable to continue production, which creates an imbalance of demands.⁹⁹ This break in the supply chain has forced many companies into bankruptcy, which has resulted in disruptions in many sectors. The total

⁹⁵ See Obeidat et al. (2017), p. 391.

⁹⁶ See Donthu and Gustafsson (2020), p. 284.

⁹⁷ See Ivanov (2020), p. 2.

⁹⁸ See Ivanov (2020), p. 2.

⁹⁹ See Ivanov and Dolgui (2020), p. 1.

impact of the crisis is difficult to measure, and the future is unpredictable. Companies that are effectively managing the current crisis have no guarantee of future success because when this crisis is over, the world will be much different than before the outbreak. Some markets will face heavy losses or will even no longer exist.¹⁰⁰

Donthu and Gustafsson (2020) stated that during a large pandemic such as COVID-19, a deep understanding of business risks can help organisations establish the appropriate plan.¹⁰¹ Additionally, they mentioned that estimating demand during COVID-19 is the greatest challenge for a company, but resilience in the supply chain can be improved by identifying risks.¹⁰² Within the supplier risk management process described in Chapter 2.6, risk identification is the first step. One category within risk identification is inappropriate demand, which is certainly the case concerning this pandemic. When this risk is identified, information must be provided about the risk, which is done in the second stage, risk assessment. How the risk will be managed is addressed in the risk management implementation phase. Finally, the entire process is monitored and can start over again in the search to identify new risks.

2.8 Research propositions

When talking about disaster risk management, one should not only look at the current situation but also in previous situations.¹⁰³ More than five years ago, there were two types of risks; firstly, extensive risk, characterised by low-severity and high-frequency. Then intensive risk which has high-severity and low-frequency. Then the term *Black Swan* events were mentioned; these are rare events that have an outsized impact.¹⁰⁴ These are events like the current COVID-19 situations. Because little is known about these types of events, there is always a need for risk assessment tools. Also, the risk for each area may differ as the risk is global but the resilience is local.¹⁰⁵ When looking at supplier risk management, the goal is to “limit the effects of supply chain disruptions that hinder the continuity of material and information flows within the supply chain” (p. 3).¹⁰⁶ During the COVID-19 pandemic, the search for supply chain resilience increases within companies. Rice and Caniato (2003) defined supply chain resilience as “the ability to respond to an unexpected disturbance and

¹⁰⁰ See Donthu and Gustafsson (2020), p. 284.

¹⁰¹ See Donthu and Gustafsson (2020), p. 288.

¹⁰² See Donthu and Gustafsson (2020), p. 288.

¹⁰³ See Mishra (2020), p. 1.

¹⁰⁴ See Mishra (2020), p. 2.

¹⁰⁵ See Mishra (2020), p. 2.

¹⁰⁶ See El Baz and Ruel (2020), p. 3.

then restore operations to normal” (p. 28).¹⁰⁷ This supply chain resilience can be positively influenced by risk management practices that are discussed in section 2.6.

Therefore, a few propositions are stated for this research. A proposition is a statement about the concepts that may be judged as true or false.¹⁰⁸ The supply risk management categorisation is separated into three categories: supplier risk, market risk and item risk. Within supplier risk, the COVID-19 situation cannot be seen as a regular environmental disaster. The size and impact of the crisis are larger than other environmental events and therefore need a firmer approach. Financially, the supplier’s solvency must be checked, and operationally, capacity constraints and quality problems arise. Strategically, the collaboration between the company and the supplier must be maintained. At the level of market risk, the number of qualified partners can decline because of bankruptcy, and prices may increase because of a supply shortage. For the item risk, some parts will be difficult to obtain, which leads to unavailability of the final product. These categories were important before the COVID-19 situation but are still relevant during the pandemic. The first proposition can be stated as follows:

Proposition 1: The current supplier risk management categorisation is still useful during the COVID-19 crisis.

For the second proposition, Donthu and Gustafsson (2020) stated that a pandemic outbreak disrupts the supply chain of a company. Resilience in the supply chain can be increased by identifying risks.¹⁰⁹ If a risk is not sufficiently identified or not identified at all, the other steps within the supplier risk management process will be less useful. Therefore, this identifying step becomes increasingly important. Donthu and Gustafsson (2020) do not test based on data but expectations. In this research, it will be tested if these expectations are true. The second proposition can be stated as follows:

Proposition 2: Risk identification becomes increasingly important within the supplier risk management process during the COVID-19 crisis.

¹⁰⁷ See Rice and Caniato (2003), p. 28.

¹⁰⁸ See Avan and White (2001), p. 50.

¹⁰⁹ See Donthu and Gustafsson (2020), p. 288.

After the risk is identified, three steps must be carried out next, and for this third proposition, it is interesting to investigate the role of the other steps. Because of the COVID-19 situation, risks are increasing, and, therefore, risk identification becomes more interesting. However, when a risk is identified, it is important to handle the other steps carefully as well. They do not become increasingly important but they remain as important as ever. Therefore, the last proposition can be stated as:

Proposition 3: The steps of risk assessment, risk management implementation and risk monitoring retain their value and remain useful in the supplier risk management process during the COVID-19 crisis.

2.9 Conclusion of the literature review

Because of the growing interest in supply risk management, it becomes increasingly important for companies to maintain the appropriate strategy. Within this strategy, risks first must be categorised, as described in Chapter 2.5. The main supply risk categories are supplier risk, market risk and item risk, and each of these risks comes with underlying sub-categories. The most important process is how to manage these risks, which is described in Chapter 2.6. Various literature has been studied, which identified many phases within risk management, with some of these phases attracting collective interest. In this research four phases are described as being the most important in various studies (see Appendix 1). These are risk identification, risk assessment, risk management implementation and risk monitoring. These phases can lead to a potential risk management strategy for Company X. Within these categories and phases, additional research must be done to assess the impact of COVID-19 on these phases.

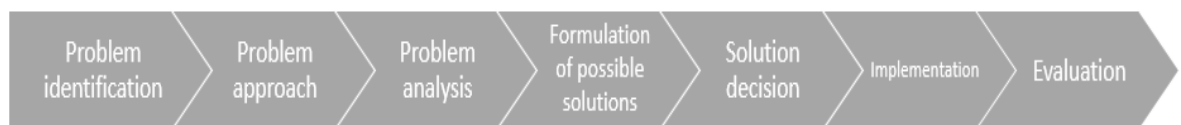
3 Methodology

As mentioned earlier, the goal of this research is to improve the supplier risk management process to help companies handle crises such as the current COVID-19 pandemic. To provide an answer to the research questions, research methods must be formulated. The methodology used to answer the research questions that are stated in the first chapter is explained in this chapter.

3.1 The general business approach by Heerkens and Van Winden (2012)

In the first section of the methodology, the theory of Heerkens and Van Winden (2012) is explained. This theory clarifies a systematic approach to solve business management problems and involves seven steps: problem identification, problem approach, problem analysis, formulation of possible solutions, solution decision, implementation and evaluation.¹¹⁰ These steps are also shown in Figure 7.

Figure 7: **Seven steps by Heerkens and Van Winden (2012)**



Source: Invented by author

Step 1: Problem identification

The core problem must be identified in the first step of the general business approach, and research must be undertaken if it is difficult to do so. First, the overall problems of the company must be inventoried; then, the relationship between the problems must be described. This relationship makes it easier to spot the core problem and choose the scope. When the core problem is stated, the variables can be chosen.¹¹¹ The problem in this research is the outdated supply risk management strategy that must be improved to handle contemporary disasters such as COVID-19. This problem has been identified by the company and discussed with the researcher and the university. The complete problem identification can be found in the introduction in the first chapter.

¹¹⁰ See Heerkens and Van Winden (2012), p. 24.

¹¹¹ See Heerkens and Van Winden (2012), p. 44.

Step 2: Problem approach

In this step, a research proposal is formulated in which research activities are mentioned. Heerkens and Van Winden (2012) stated three main components for this approach; can, know and choose. The first component describes all of the activities that need to be executed, the second is the collection of knowledge about the research topic, and the third is the establishment of the scope of the research process.¹¹² These steps are carried out in Chapters 2 and 3 of this research.

Step 3: Problem analysis

An assessment of the problem is already outlined in the previous two steps, but further details must be examined to gain a better view of the bottleneck. These data can be found through qualitative and quantitative research. For this research, business documents and in-depth interviews are used. This method of research was chosen because it is an internally identified problem that must be investigated within the company. The interviews provide internal information about the company from the employees' own experience. Next, business documents offer additional information to formulate a more reliable solution.¹¹³ This problem analysis is executed in Chapters 2 and 4.

Step 4: Formulation of possible solutions

In this fourth step, possible solutions are generated and assessed. Firstly, the decision-making process is described and determined, and criteria that the final solution must satisfy are established. Each attribute must be measured to investigate which solution fits the best according to the criteria. This can be done by creating scores for criteria measurement, making comparisons possible before selection of the best solution.¹¹⁴ This formulation of solutions and criteria is investigated in section 2.6.1.

Step 5: Solution decision

Here, a choice is made among the possible solutions discussed in the prior step. In many business issues, this step is done by the client, but in this research, this step is also done by the researcher,¹¹⁵ based on the results collected in Chapter 4.

¹¹² See Heerkens and Van Winden (2012), p. 60.

¹¹³ See Heerkens and Van Winden (2012), p. 68.

¹¹⁴ See Heerkens and Van Winden (2012), p. 80.

¹¹⁵ See Heerkens and Van Winden (2012), p. 102.

Step 6: Implementation

In this step, the chosen solution must be implemented by the company. Within this implementation, a two-part plan is made: The first part is technical, in which the processes to be carried out are described, and the second part is social, in which the role of people in this process is described.¹¹⁶

Step 7: Evaluation

The evaluation is the last step of the business approach and is executed at some point after the plan is implemented. The evaluation for this research will not be done by the researcher because of the limited time.

3.2 Data collection and sample

Data were collected by conducting in-depth interviews with 11 employees of the purchasing departments of Company X. These data provided answers to research questions 1.1, 1.2 and 1.3. These respondents were carefully selected in consultation with the university's supervisor and the supervisor from Company X. The respondents were selected based on their function and knowledge about the research subject, meaning that they have contact with the supplier, notice the supplier risks involved or can affect the supplier risk management process. These tasks are completed by several people, so this creates a representative view. The plan was that, if no new information was obtained after a certain number of interviews, the remaining interviews would be cancelled. The interview respondents are listed in Table 1. This is what happened: 13 interviews were planned, of which two were eventually cancelled because enough insights had been gained.

¹¹⁶ See Heerkens and Van Winden (2012), p. 112.

Table 1: Interview respondent list

No.	Functions	Years of service
1	Project procurement manager	12 years
2	Commodity manager	12 years
3	Commodity manager	11 years
4	Commodity manager	13 years
5	Category buyer	40 years
6	Category buyer	31 years
7	Tactical buyer	4 years
8	Supplier performance manager	14 years
9	Component engineer	10 years
10	Manager final assembly	40 years
11	COO Company X	13 years

After authorisation was obtained from the ethics committee, invitations for the interviews were sent via the Company X e-mail to 11 employees, informing them about the research and the interviews. Next, the participants were asked if they were willing to participate in a 30-minute to one-hour interview and also were asked to select a date for the interview within two weeks after the e-mail was sent. Additionally, they were invited to ask questions if they lacked clarity.

3.3 Semi-structured interview

Three types of interviews are stated in the literature: unstructured, semi-structured and structured. The more structured the interview, the more control the interviewer has over the interaction.¹¹⁷ For this research, the semi-structured type of interview was used, for two reasons: It results in more detailed data, which is the goal in qualitative research, and it allows for deep investigation of a topic. A guide for the interview was used, listing questions and topics for discussion. While the questions were formulated beforehand, the order in which they were posed during the interviews could change.¹¹⁸ Harrell and Bradley (2009) suggested that a semi-structured interview should consist of seven parts, which are discussed below.

¹¹⁷ See Harrell and Bradley (2009), p. 25.

¹¹⁸ See Harrell and Bradley (2009), p. 27.

Frame the research

In this part, researchers must make clear what they want to learn from the respondents. The problem must be specified and the research question must connect to this, as posed in Chapter 1. Within this framing, the number of participants must be established.¹¹⁹ The selection of participants is established in Chapter 3.2.

Sampling

The number of participants is stated in the previous part, and in this part, it is time to choose the participants. Several methods can be employed, namely, random, systematic, structured, cluster, judgement, convenience, opportunity and snowball. In this research, the sample is chosen by convenience, which means participants from the same company are chosen because of their knowledge about the topic.¹²⁰ The sample includes respondents from several departments related to risk management and those who are in contact with suppliers. Within these departments, the managers are selected because of their knowledge. This selection is chosen in collaboration with the research supervisor from Company X and is described in Chapter 3.2.

Design questions and probing

There are three types of interview questions – descriptive, structural and contrast – and most interviews employ all of these types. Descriptive questions provide new information, structural questions investigate a relationship between variables and contrast questions address terms to clarify subjects for the interviewer. The questions should be grouped by topic to create a clear line in the conversation. To obtain the best results possible, each of these types of interview questions was used in this research. Probing questions are used in interviews when an answer is not clear or the interviewer wants to know more about a subject.¹²¹ Probing questions are not formulated beforehand but arise during the interview. An example of a probing question is, “Can you be more specific?” The research questions are listed in Appendix 5.

¹¹⁹ See Harrell and Bradley (2009), p. 30.

¹²⁰ See Harrell and Bradley (2009), p. 32.

¹²¹ See Harrell and Bradley (2009), p. 44.

Developing the protocol

Within this step, the structure of the interview is developed, clarifying the formation of the questions and probes that must gather all of the information the researcher needs to learn. Within this structure, it is important to take into account the time the interview will last, allowing the interviewer to pose questions of priority in case time is short.¹²²

The design for interviews can differ, and there are several protocol schemes for interviews. Harrell and Bradley (2009) mentioned four of these schemes with different types of questions. First is the funnel protocol, in which the interviewer begins with broad questions which then lead to more specific questions. In other words, the most important questions are asked at the end of the interview. Next is the inverted funnel, which is almost the opposite of the first funnel protocol, allowing the interviewer to begin with specific questions that eventually lead to broader questions. These specific starting questions introduce the respondents to the topic and allow them to feel comfortable; they are often used when the respondent is shy. The third is the tunnel protocol, often used when limited time is available for the interview. In this method, broad questions are omitted and, instead, there are a series of similar questions. The last method is the quintamimensional protocol, in which the opinions and attitudes of the respondent towards the subject are key, and the questions are designed to elicit them.¹²³ The first method, the funnel protocol, was used in this research. This is the most common design and is the one in which the interviewer is more likely to receive relevant answers. Additionally, this method allows the researcher to identify content to be explored in more detail later in the interview.

With this funnel protocol, there is also a format for the structure of the interview itself. This begins with a personal introduction, in which the interviewer also describes the purpose of the research and explains why the respondent was chosen. Second are the ground rules, in other words, the formal information about the interview, such as its length and confidentiality. Next are the questions and probes as discussed in the previous section. This is the most important part of the interview because the needed research answers are gathered here. The interviewer must keep an eye on the clock, to ensure that all of the important questions are posed before time expires. Lastly, the interviewer must thank the respondent for participating in the interview and must arrange for the communication of any final notes.¹²⁴

¹²² See Harrell and Bradley (2009), p. 49.

¹²³ See Harrell & Bradley (2009), p. 50.

¹²⁴ See Harrell & Bradley (2009), p. 52.

This interview protocol does not allow the respondents to receive the interview questions beforehand, to ensure that they cannot think about the questions and provide a more formal and official answer than is desired. This process must be observed for all participants, to make certain that each interviewee's answers are relevant. Every respondent must be processed in the same way.¹²⁵ The interview structure, which was similar for each respondent, is represented in Appendix 5.

Preparing for the interview

As an interviewer, one must focus on a few factors to ensure the success of the process. Harrell and Bradley (2009) suggested a few important components: (1) Gain cooperation and stay involved in the interaction; (2) Listen, to determine whether questions need additional follow-up; (3) Be neutral, keeping one's own opinion quiet and letting the respondents tell their stories because there is no right answer; and (4) Be confidential, able to keep secret information for themselves.¹²⁶

Conducting the interview

Firstly, a location for the interview must be chosen; a quiet, private room makes certain there will be no distractions. An interviewer must remain neutral at all times, offering explanations, expressing interest and repeating the respondent's answers, for clarity. In closing, appreciation must be expressed and the respondent must be informed about the next steps.¹²⁷

Capturing data

The last part is about capturing the collected data. The most important capturing technique for this research is to record the interview. With this record, the interviewer can listen to the entire conversation to guarantee clarity, although a recording does not capture all data, such as non-verbal communication. Therefore, it is important to take notes during the interview as well.¹²⁸ The data capture is discussed in the following section.

¹²⁵ See Harrell & Bradley (2009), p. 49.

¹²⁶ See Harrell & Bradley (2009), p. 57.

¹²⁷ See Harrell & Bradley (2009), p. 71.

¹²⁸ See Harrell & Bradley (2009), p. 75.

3.4 Transcribing, coding and analysing the interviews

After the interviews were planned and carried out, the interview recordings, made on a mobile telephone, were transcribed. Oliver, Serovich and Mason (2005) suggested two different ways in which an interview can be transcribed. The first is naturalised transcription, in which the interview is transcribed in a highly detailed way. Everything must be noticed, including pauses, the tone of the respondent and the respondent's breathing patterns. This way of transcribing is often used in conversation analysis studies.¹²⁹ The second is denaturalised transcribing, which pays more attention to the information imparted in the conversation than to how it was told. This second method of transcribing was used for this research, resulting in understandable information that eliminated needless elements.¹³⁰

After the interviews were transcribed, the interviews had to be coded. Blair (2015) stated that coding consists of three phases.¹³¹ The first is open coding; in this stage, the concepts from the text are labelled. In the second phase, axial coding, the researcher identifies relationships between the labels. Last is selective coding, in which main categories are selected and all other labels are related to these categories.¹³²

Next, within the coding, the process can be divided into deductive and inductive coding. The deductive approach is based on existing theory, and a strategy is designed later to test this theory. With the inductive approach, the researcher begins with tests and observation and the theory is proposed at the end of the research process.¹³³ Since this current research begins with existing theory, and the observations and tests are based on this theory, the deductive coding approach is used. A system called Atlas.ti, which was recommended by the University of Twente, was used for the coding. This program helps arrange and manage the qualitative data from the interview in a systematic way. Coding was done for each question, and the answers of the various respondents were compared. These comparisons were made based on terms called codes, with the codes used for this research stated in Table 2 below.

¹²⁹ Oliver et al. (2005), p. 1273

¹³⁰ Oliver et al. (2005), p. 1273

¹³¹ Blair (2015), p. 17.

¹³² Blair (2015), p. 18.

¹³³ Christians and Carey (1989), p. 360.

Table 2: **Codebook**

Category	Sub-category
Supplier monitor process	Factors
	Systems
	Communication
	Effect COVID-19
Supplier risk management categorisation	Effect COVID-19
Supplier risk	Environmental
	Financial
	Operational
	Strategic
Market risk	Capacity
	Price
	Number of suppliers
Item risk	Availability
	Understanding
Risk management process	Steps
	Risk identification
	Risk assessment
	Risk management implementation
	Risk monitoring
	Effect COVID-19

3.5 Business documentation

Next to the information acquired from interviews, it is helpful to use data from business documentation, which can include all types of material available in the Company X database. The information is kept up to date by various departments and is checked by relevance. Examples of relevant business documentation are the documents about the current and previous supplier risk management strategy that is investigated in the second research question.

These details can supplement the information obtained in the interviews, because it is possible that respondents did not have comprehensive knowledge about the research

subject, making it useful to study the documentation.¹³⁴ Data from business documents might contradict information gleaned from the interviews. When this is the case, this contradiction requires additional research, which can be more interviews or extra documents. This is chosen when it appears that the data obtained from the documentation is different from the interview data.

Additionally, business documentation was used in the first two chapters of this research to introduce the problem and explain the topic. The interviews based on this topic are also indirectly linked to business documentation. Next, the research questions – such as researching the current supplier risk management process, monitoring the supplier risks and investigating the impact of COVID-19 on the risk management process – can be answered only using documents or in combination with the interviews. Therefore, business documentation was used for all research questions, the answers to which are provided in Chapter 4.

3.6 Validity and reliability

Many definitions of validity are found in the literature. Winter (2000) stated that a common definition of validity does not exist.¹³⁵ Creswell and Miller (2000), as reported in Golafshani (2003), suggested there is no common definition because validity is affected by the researcher's perception and therefore the created validity concept.¹³⁶ Some definitions from various articles are mentioned next. Black and Champion (1976) defined validity as “the measure that an instrument measures what it is supposed to” (p. 232).¹³⁷ Hammersley (1987) defined validity as “an agreement between two efforts to measure the same thing with different methods” (p.75).¹³⁸

Next, validity requires that an instrument is reliable, but an instrument can be reliable without being valid.¹³⁹ Distinction invalidity is often made among three types: First is construct validity; “this determines which data are to be gathered and how they are to be gathered” (p. 20).¹⁴⁰ In other words, it is the extent to which the measurement used is testing the theory it is measuring. Second is content validity; this investigates whether the test is representative of what it aims to measure. The third is criterion-related validity, at which the

¹³⁴ See Van Aken and Berends (2018), p. 180.

¹³⁵ See Winter (2000), p. 1.

¹³⁶ See Golafshani (2003), p. 602.

¹³⁷ See Black and Champion (1976), p. 232.

¹³⁸ See Hammersley (1987), p. 75.

¹³⁹ See Kimberlin and Winterstein (2008), p. 2278.

¹⁴⁰ See Wainer and Braun (1998), p. 20.

results will be compared with the results of a different test to see if they correspond with one another.¹⁴¹ These methods are normally used for quantitative research, but Riege (2003) stated that these methods can also be used in a case study. This can be assured by using multiple sources of evidence, such as interview transcripts and business documents, making use of diagrams and illustrations to support the findings and creating support from theoretical research design.¹⁴²

Second is reliability, which is defined by Joppe (2000) as “the extent to which results are consistent over time, are an accurate representation of the total population under study and can be reproduced under a similar methodology” (p. 1).¹⁴³ Although reliability was originally used for evaluating quantitative research, reliability is a concept within high-quality research to evaluate quality in a quantitative study.¹⁴⁴ Patton (2002) stated that every qualitative researcher must take validity and reliability into account in their qualitative research.¹⁴⁵ Three types of reliability are discussed in the literature: test-retest reliability, internal consistency and interrater reliability.¹⁴⁶ First, test-retest reliability is also known as stability; it tests the correlation between two measuring points at two different times with the same individual. Within this test, it is important that the same process and timing are used; in other words, the same test will be provided to the same people at a different time.¹⁴⁷ Second is internal consistency, in which one tests whether a survey measures what it is designed to measure. The measured items are intended to evaluate the same construct, which results in a correlation between these items.¹⁴⁸ Last is interrater reliability, also called an interobserver agreement, which measures whether the observer has consistent judgements about the observation. In other words, it measures the extent to which various observers agree with each other.¹⁴⁹ Reliability in case studies can be assured by adding theory for every research stage, recording and transcribing the interviews and making use of a semi-structured case study. These elements are present in this research.¹⁵⁰

¹⁴¹ See Kimberlin and Winterstein (2008), p. 2279.

¹⁴² See Riege (2003), p. 82.

¹⁴³ See Joppe (2000), p. 1.

¹⁴⁴ See Golafshani (2003), p. 601.

¹⁴⁵ See Patton (2002) 317

¹⁴⁶ See Kimberlin and Winterstein (2008), p. 2277.

¹⁴⁷ See Kimberlin and Winterstein (2008), p. 2277.

¹⁴⁸ See Kimberlin and Winterstein (2008), p. 2277.

¹⁴⁹ See Kimberlin and Winterstein (2008), p. 2277.

¹⁵⁰ See Riege (2003), p. 83.

3.7 Operationalisation

Within this operationalisation, concepts are translated into measurable observations, which also increases the reliability of the research. The goal of the operationalisation is to choose variables for the research indicators, which derive from the concept of the research. The concepts derive from the main research question; these concepts are the supplier risk management process and COVID-19. The operationalisation for this research is further clarified in Table 3 below.

Table 3: Operationalisation

Concept	Variable	Sub-variables	Indicators
Supplier risk management process	Supplier monitor process	Factors	Price, quality, delivery, flexibility, process capability, innovation and lead-time
		Systems	Quantitative rating system, performance reviews and communication and development of the partnership
	Supplier risk management categorization		
	Supplier risks	Environmental	Accidents, socio-political actions or climatic conditions
		Financial	Supplier default, insolvency and bankruptcy
		Operational	“Capacity constraints, inability to reduce cost, incompatible information systems, quality problems, unpredictable cycle times, and volume and mix requirement changes” (p. 18). ¹⁴⁸
		Strategic	Collaboration between buyer and supplier
	Market risks		Global sourcing
			Market capacity constraints
			Market price increase
			Number of qualified suppliers
	Item risks	Impact on profitability	Availability of the product
		Nature of product application	Product understanding
	Supplier risk management process	Risk identification	“Inappropriate demand, fulfilling customer deliveries, cost management and pricing, and weaknesses in resources, development and flexibility” (p. 51). ¹⁴⁹
		Risk assessment	Understanding, implementing and costs
Risk management implementation		Risk transfer, risk taking, risk elimination, risk reduction and further analysis of risks	
Risk monitoring		Controlling	
COVID-19	Supplier monitor process		Effect COVID-19
	Supplier risk management categorization		Effect COVID-19
	Supplier risk management process		Effect COVID-19

¹⁵¹ See Zsidisin (2003), p. 18.

¹⁵² See Hallikas et al. (2004), p. 51.

3.8 Conclusion of the methodology

A case study – an in-depth type of research that focusses on contextual understanding, the human actions and interpretations of a case or cases, relying on multiple data sources – was used in this research.¹⁵³ A case study can be useful for generating and testing hypotheses because it focusses on a specified group to test or generate new theory. Case studies usually provide their information from documents, records, observations and interviews, with interviews being the most frequently used sources.¹⁵⁴ In this research, 11 interviews were conducted with employees from various departments in Company X who have close relationships with the suppliers and risk management officers. The semi-structured interviews were based on the seven parts discussed in Chapter 3.3, and the transcriptions were coded based on the techniques described in Chapter 3.4. Additionally, business documentation was used as confirmation of information gathered in the interviews.

¹⁵³ See Yin (2003)

¹⁵⁴ See Walsham (1995), p. 78.

4 Results

4.1 The current supplier monitoring process

In the first sub-question, the current supplier monitoring process is described for Company X. In theory, three subjects related to the current supplier monitoring process were defined, namely, the monitoring factors, monitoring systems and the monitoring communication. These three topics are examined in the interviews and business documentation. The interviews and coding can be found in the appendix book.

Monitoring factors

The most important factors on which Company X's suppliers are monitored are on-time delivery and on-conformity delivery. Both factors were mentioned by eight of the 11 respondents, while two of the remaining three respondents did not mention any specific factors. On-time delivery is a key performance indicator that measures the extent to which purchased goods arrive on time. The delivery time is determined in consultation with the supplier, and the indicator measures to what extent this condition is met. On-time delivery is important for Company X for three reasons: no time wasted by waiting for materials, maintenance of the production schedule and on-time delivery of Company X's products. The second factor mentioned is on-conformity delivery. This is an indicator of the performance and quality of the delivery, which must meet predefined requirements. If these requirements are not met, the delivery is non-compliant; this is also referred to as non-conformity.

In addition to these two factors, the financial status of the supplier and Company X's relationship with the supplier are monitored continuously. Financial monitoring is critical to avoid surprises, such as sudden bankruptcy; relationship monitoring examines communications between the supplier and Company X, checking whether the supplier has the same goals and values as Company X does. This is discussed later in this section. Suppliers are not monitored on price because this is stipulated in the contracts, from which there are no deviations

Monitoring systems

The most frequently mentioned system in the interviews (named by seven of 10 respondents) is Oracle, which is Company X's ERP system. Oracle is a software which processes daily business such as financial management, supply chain management, project management, accounting and procurement. To mitigate the risks of the above factors, Company X created two files at the beginning of the pandemic. In these files, data is retrieved from Oracle. The

problem is that these files do not work efficiently and effectively. These two files are discussed further in 4.2.2.1. Additionally, Cognos, Fracas and E-acquisition were all named three times in the interviews. Cognos is a reporting and analytical tool used to perform data combinations and create user-friendly detailed reports. Cognos extracts all of its data from the Oracle system. On-time delivery and on-conformity delivery are both measured with Oracle. Fracas compiles observations about the quality of the delivered products and keeps track of the rejected materials. Additionally, Fracas provides feedback to the supplier, including observations about quality. With E-acquisition, Company X can place several suppliers next to each other for comparison purposes. Various factors are examined to help determine the company's best supplier. Lastly, various qualification tests for which there are no systems are conducted manually on the large radar systems on ships.

Monitoring communication

Communication is highly important in the supplier monitoring process, in which the cooperation and performance of the supplier are evaluated. This is done based on reports taken from Cognos. For suppliers that deliver often, this is a monthly process; for suppliers with fewer deliveries, this is done once a quarter. If errors or problems are discovered earlier, communication will, of course, take place sooner. For most suppliers, this is done by the contact or tactical buyers. For large suppliers or complicated cases, the monitoring is done by a supplier account team.

Conclusion

On-time delivery and on-conformity delivery are the main factors on which the suppliers of Company X are monitored, and the factors are measured in the Oracle ERP system. Company X also uses other systems to measure on-time and on-conformity delivery. Fracas is used to monitor quality and to keep track of the rejected materials. Finally, the suppliers are rated on different factors in E-acquisition with the results discussed with the suppliers weekly or monthly. Cognos is used to discuss the report with the suppliers. The final results are discussed with the suppliers every week. The problem within Company X is not in the factors or the communication towards the supplier. The most important factors are known and communication proceeds well. The problem lies in the newly created files that help during the COVID-19 situation. The operation and shortcomings of these files will be discussed in the following sections.

4.2 Current supplier risk management process

In the second sub-question, the current supplier risk management process is examined for Company X by analysing data derived from the interviews and business documentation. In the interview, questions were asked about the supplier risk manager categorisation and the current supplier risk management process. The interviews and coding can be found in the appendix book. The following paragraphs first describe the categorisation and then the process.

4.2.1 Current supplier risk management categorisation

For the current supplier risk management categorisation, the respondents were questioned based on the categorisation described in Chapter 2.5: supplier risks, market risks and item risks of suppliers.

Supplier risks

Supplier risks are distributed into four risk categories: environmental, financial, operational and strategic. Environmentally, the greatest risks for Company X are political and legislative requirements regarding its military products. Company X must consider the laws of its own country, the country of the supplier and sometimes even the country of the supplier's supplier. Company X specifies quite clearly in the contracts when a supplier is responsible for providing certain information. A second risk is that a growing number of materials are seen as dangerous to humans and nature, with some currently acceptable materials likely to be prohibited in the future. In these cases, Company X must seek alternative ways of providing the same functionality with different materials, and these solutions can be expensive.

Financially, it is important to know how a supplier is doing and whether it is dependent on Company X's contracts. This financial position is determined based on a Dun & Bradstreet report that assesses creditworthiness. However, these figures are often not entirely up to date and are therefore not relevant to the recent COVID-19 situation. An alternative report is available with current figures, a so-called "oiler analysis", but it is costlier. Additionally, Company X's contact person can directly ask questions of the supplier concerning its financial status.

Audits are conducted to prevent or detect operational risks at an early stage. These audits examine performance, delivery and quality. For some categories, this is done at a

meeting where quality, logistics, technology and costs are monitored. The operational risks for Company X are the small engineering departments at some suppliers because they operate in a niche market. As a result, knowledge is available to only a few people, so it can quickly be lost.

Strategically, Company X must work with suppliers who share the same goals. Because Company X makes state-of-the-art products, suppliers must also supply state-of-the-art parts. This is achieved by drawing up joint roadmaps encompassing long-term planning in which goals are matched with technologies. Furthermore, Company X buys strategically, this relates to the entire procurement process, and internationally to ensure that it has substantial leverage over its suppliers.

Market risks

The greatest market risk for Company X is its low number of suppliers. Company X works with a single source for many of its products because it operates in a niche market in which few suppliers are available. Additionally, not every supplier is suitable, because Company X manufactures state-of-the-art products and therefore buys only the best materials. The market for many of its product groups is restricted because, due to legislation, Company X does not purchase from China. Finding an alternative supplier is often a long and costly process. To reduce the risk, Company X draws up contracts in which it confirms its priority, whereby it takes over the intellectual property when a supplier is no longer able to fulfil its contracts. If the risk is too great, Company X looks for an alternative product or technology. For technologies, the company has set a standard of ensuring more than one supplier, but because Company X is relatively small and often takes small volumes, it is not a core business for most suppliers. Suppliers can also be taken over by automotive industry companies, and as a result, Company X's product group may disappear from a supplier.

The next greatest risk is obsolescence, but Company X can decrease this risk by letting the suppliers determine the parts themselves to ensure that they are responsible. Then, it is contractually agreed that the product will form, fit and function under the requirements of Company X. As a final risk, the category buyer (see interview 8) predicted that in the future the market will be dominated by China, which is a major risk for Company X because it does not use Chinese products for its radars.

Finally, the impacts of price increases are negated by the respondents who work with contracts in which the price is fixed for a lengthy period. These prices do not change in any way other than the normal fluctuations in currency exchange rates.

Item risks

The two greatest item risks are the availability and knowledge of the products. As discussed in the previous section, the availability of supplies for Company X can be scarce, with legacy products and obsolescence of significant concern. Consequently, Company X must seek beneficial agreements in their contracts to manage this. When a component is becoming obsolete, the employees of Company X often realise this in time, giving them five years to find an alternative. Due to the complexity of the components, knowledge is also quite scarce. Additionally, Company X works with old systems, and, as a result, institutional knowledge can fade away at the supplier. As discussed earlier, Company X must indicate in the contract that it will take over the knowledge when a system can no longer be delivered. Company X's philosophy is to buy as high up the supply chain as possible.

4.2.2 Current supplier risk management process

In the theory, the supplier risk management process is divided into four steps: risk identification, risk assessment, risk management implementation and risk monitoring. The interviews revealed that these four steps are also used by Company X, with the working method being the same even though the specific description may differ. Risk identification is the first and most important phase, carried out using E-acquisition, in which current and new suppliers are evaluated for different variables, such as finances, reliability and technologies. This identification happens regularly and depends on the type of product. The category technology team drafts an annual category technology plan in which it identifies risks per category. As a second phase, a risk mitigation plan is drawn up. For some of Company X's product groups, this was not done for years because there were no high-risk suppliers. In a mitigation plan, the possibilities are described when a major supplier disappears. An alternative supplier or redesign can be considered, and the costs of this are also calculated. Additionally, risks can be prevented beforehand by having a long-term contract or an alternative supplier in place. The problem in Company X is that many of these risk plans are outdated and are no longer periodically evaluated by the category technology team. Furthermore, many good mitigation plans are not being used. The responsibility for this lies with the program of the category. There is no investment in them and they do not

receive any help from the management. Things are therefore going wrong here in the third phase of the process, the implementation.

The category buyer (see interview 1) provides an example of a case in which the situation went wrong:

“Norma is a factory where we outsourced our mechanical department 10 years ago. Here we have seen for 10 years that, in the long run, this is a company that may not quite suit us. We saw for 10 years that they were a risk because we depended on them. When we stopped working together, we did not know what to do and we had to find another partnership as soon as possible. So we could have seen this coming for 10 years. We knew that Norma was a risk but we thought, ‘There are hundreds of others who can do the same’. Only then is the question of how quickly these others will be ready to take over this entire production. This would have to be investigated in advance” (p. 5).

4.2.2.1 Current supplier risk management systems

PUR102

At the beginning of the pandemic, Company X launched two systems to identify and mitigate risks. Both files are run from Excel, with the first called PUR102, taken from the Oracle ERP system. Here, the tactical buyer indicates per PO line what the probability is that delivery will be late, what the impact will be and whether mitigation actions will be taken. A score of 1 (very low) to 5 (very high) is assigned for the probability and impact. When the probability of a delivery being late is very low, it is given a score of one; when the probability is very high, it is given a score of five. The extent to which delivery is late is shown as impact. Delivery time is the only impact factor measured in this process. This was decided because delivery is the most important factor and this delivery time can be delayed during a pandemic. In 4.1.1 it was shown that besides this delivery time, quality is an important factor. This quality may not pose a big risk in the current pandemic, but it can do so in a new situation. As the new risk management strategy will be a long-term strategy, this factor must be included in the process.

For the mitigation action, a “yes” or “no” is indicated. Figure 8 illustrates how the values are distributed. For the impact factor, this is a guideline, because for some products this time indication is much shorter or longer. Moreover, another factor, RPN, is mentioned in the file. This is indicated at the bottom of Figure 8 and measures the average value between probability and impact. This RPN is a tool in the PUR102 that simplifies the conclusion as to which supplier poses a risk. If this value is medium or higher, a risk mitigation plan must

be undertaken. The example in Figure 8 demonstrates that no risk mitigation plan is undertaken when the risk is very high. The PUR102 was a temporary file for use during COVID-19, but because of its operation, Company X wants to continue it as a fixed risk management system. But this system needs to be improved to be used as a fixed risk management system.

Figure 8: **PUR 102 guideline**

Probability		Impact		Risk Mitigation Plan	
Very low 1	Will not happen	Very low 1	No delay	Yes	Supplier has planned mitigation actions to reduce the probability and/or limit the impact.
Low 2	Not likely to happen	Low 2	Small delay < 1 week		
Medium 3	Likely to happen	Medium 3	Delay < 3 weeks		
High 4	Very likely to happen	High 4	Considerable delay < 6 weeks	No	Supplier has no planned mitigation actions
Very high 5	Will happen	Very high 5	Huge delay or No-delivery > 6 weeks		

Probability	Impact	RPN	RPN (P * I)	Risk Mitigation Plan
Very high	Very high	25	5 Very high	No

Source: Company X PowerPoint instruction risk COVID-19

COVID-19 master file

The second system is again an Excel file and is called the COVID-19 master file. In this master file, the data from the PUR102 is processed, and the category buyer is responsible. Where the PUR102 is examined per PO line, the COVID-19 master file looks at the number of high-risk PO lines per supplier. A score from very low to very high in terms of risk is attached to this for each supplier, this does not normally happen per PO line. The score that each receives depends on the number of risky PO lines that a supplier owns. If the risk of the supplier is medium or higher, this must be mitigated. This is done for a standard number of medium- or higher-risk PO lines but does not take into account the total number of the supplier's PO lines. This means that supplier A, with 500 PO lines of which ten PO lines are medium or higher, is assessed at the same level as supplier B, with 50 PO lines of which ten PO lines are medium or higher. In this case, supplier B is a much greater risk and therefore a more urgent focus than supplier A. For clarification purposes, this situation is outlined in Table 4. It shows that in the current situation, with a risk minimum of 10 risky PO lines, both suppliers pose a risk, whereas in the new situation, with a percentage of 5%, only supplier A poses a risk.

This master file also indicates whether a supplier has claimed *force majeure*, which is a clause in the contract that releases both parties from liability in the event of a situation

such as a pandemic. The intention is that this COVID-19 master file is a temporary file that will not be used after the pandemic. If this file turns out to work better, it can be continued.

Table 4: COVID-19 master file PO line framework

	Supplier	Risky PO lines	Total PO Lines	Percentage risky PO lines	Risk minimum
Current situation	Supplier A	10	50	20%	10 risky PO lines
	Supplier B	10	500	2%	
New situation	Supplier A	10	50	20%	5% risky PO lines
	Supplier B	10	500	2%	

COVID-19 Watchtower

The PUR102 and COVID-19 master file results are discussed weekly or every other week in the COVID-19 watchtower. This is a scheduled meeting with all managers per product category. This watchtower examines which PO lines have a risk of medium or higher – or average risk of medium or higher – and how this will be mitigated. In this COVID-19 watchtower, the mitigation plans discussed are not always met. Additionally, it is also discussed which suppliers have claimed *force majeure*. The results are compared with previous weeks to determine whether there has been an increase in risk.

Conclusion

Company X recognises the supplier risk management process categories, but they are not divided as precisely as those discussed in the literature. Many of these criteria are used as selection criteria to determine which suppliers are suitable for Company X. The selection criteria also differ for each product group. As an example, for one product, the weight of a component is highly important while for another it is completely irrelevant. When it comes to supplier risks, Company X must consider the political and legislative requirements of various countries from an ecological point of view. Moreover, Company X needs to know how its suppliers stand financially and whether they need assistance, and this must be measured against recent figures. Various operational risks are identified through audits. Furthermore, Company X must maintain its relationships using roadmaps. Its limited number of suppliers is the greatest risk in the market, and as a result, Company X frequently works with single sources. Besides, products can become obsolete. Finally, the availability and knowledge of the product are the most significant item risks. Ultimately, Company X can cover many risks by drafting beneficial contracts. This is sometimes not properly

complied with, which leads to problems after all; an example of this is discussed in section 4.2.2. Concerning the current supplier risk management process, Company X follows the same steps as described in the theory, with an emphasis mainly on risk identification and mitigation. The mitigation plans are often in place, but attention is either not paid to them or they are outdated. In this supplier risk management process, two documents are used – the PUR102 and the COVID-19 master file, which use PO lines to determine whether a risk is present. Problems were found in these files. For example, in the PUR102 the impact is measured only on delivery time and not on quality. Also, in the COVID-19 master File, no comparison is made between the number of high-risk PO lines and the total number of PO lines of a supplier. In the end, the results are discussed in the COVID-19 watchtower, but these mitigation plans are not always met.

4.3 Impact of COVID-19 on the risk management process

The impact of COVID-19 on the risk management process is measured within the risk monitoring, categorisation and management process. Each interview subject was asked to assess the impact of COVID-19 on this process; the interviews and coding can be found in the appendix book.

4.3.1 Impact of COVID-19 on the supplier monitoring process

In the early days of the pandemic, a methodology was established to uncover risky PO lines, consisting of two files discussed in Chapter 4.2.2.1. Secondly, there are weekly watchtowers in which the status of a supplier is discussed and actions are taken when a supplier falls short. For the rest of the monitoring process, little changed for most segments, with the major problem being that physical contact with the supplier is no longer possible. This makes doing business more challenging but certainly not impossible. Furthermore, the suppliers are not monitored more than usual because this is already done to the maximum.

4.3.2 Impact of COVID-19 on the supplier risk management categorisation

The greatest problem indicated by the respondents is the delay in delivery time. Suppliers' factories have stood idle due to lockdowns in several countries. As a result, they were unable to continue manufacturing and this resulted in a delay in delivery. Another complicating factor is the cessation of transport methods such as air cargo. When suppliers were unable to deliver on time, they claimed *force majeure*. These delays have caused only a few crucial problems for Company X because its customers understand the situation. Additionally,

Company X does not need some deliveries directly because it traditionally operates with a delivery time buffer.

Suppliers are monitored financially because of the COVID-19 situation, but this is a more difficult process because physical inspections are impossible and Dun & Bradstreet reports are not current. Company X's market and that of its suppliers has not been significantly harmed by the pandemic, while suppliers active in the aeronautical industry have been hit particularly hard. None of Company X's supplies has declared bankruptcy. If a supplier is about to fail, senior management will respond, seeking alternatives or determining how many products or semi-manufactured products the supplier still has in stock. Furthermore, prices have not changed for Company X because it works with price-fixed contracts. Lastly, Company X has stopped ordering large new machines because of these uncertain times, and this strategy will probably continue through the end of next year.

4.3.3 Impact of COVID-19 on the supplier risk management process

Due to the COVID-19 situation, the first phase of the supplier risk management process, risk identification, has become more important. Because risks are occurring now or are likely to occur, more attention is paid to this phase. Also, risk monitoring appears to be becoming more important. This is mainly done in the weekly COVID-19 watchtower or by employing the COVID-19 master file and PUR102 file. In this monitoring, it is important to measure the appropriate key performance indicators for each product, as these can differ. For example, on-time monitoring for some products is highly important while it is irrelevant to others. The correct theory has been mapped out, but there are problems with its execution. Additionally, the COVID-19 master file is only a temporary file and not a long-term strategy. Therefore, a long-term strategy is the aim of this study.

Conclusion

COVID-19 has had a significant impact on the delivery times of suppliers, as factories were closed due to lockdowns and transportation systems were affected, resulting in fewer deliveries. Until now, this did not have a major impact on Company X because it worked with stock or because customers understood the situation. However, Company X employees could not visit their suppliers, which resulted in some small challenges. Furthermore, COVID-19 did not have a major impact on various processes within the purchasing department. Although COVID-19 has not had a major impact on Company X to date, an

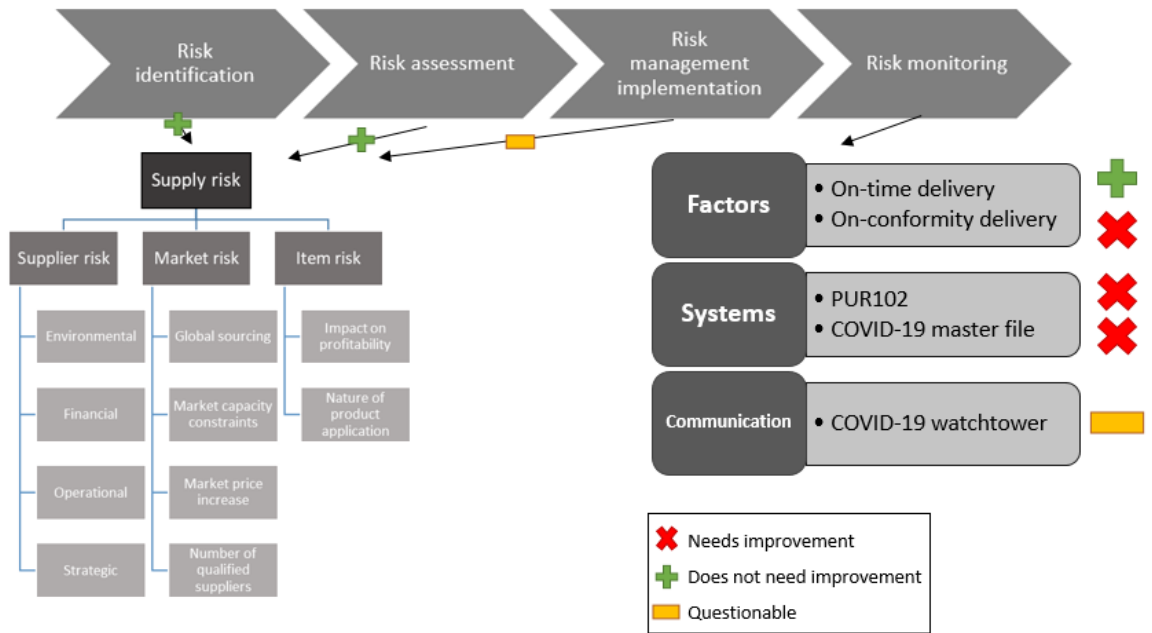
improvement to the supplier risk management strategy must be considered. There are two reasons for this; firstly, this impact from COVID-19 can still come as the pandemic is still in full swing. Secondly, it becomes a long-term strategy where risks can always occur.

4.4 Problem clarification

For the problematization of this chapter and the entire study, Figure 9 has been prepared. It shows which phase the problems are located. This is important to see how the final supplier risk management process can be improved. The outlined supplier risk management process consists of the four steps mentioned in section 2.6. The first three steps, risk identification, risk assessment and risk management implementation include the different risk categories discussed in section 2.5. In these different categories, different risks occur. The greatest risk is the availability of products and suppliers because of the niche market in which Company X operates. To reduce the risk, Company X draws up contracts in which it confirms its priority, whereby it takes over the intellectual property when a supplier is no longer able to fulfil its contracts. Here, the risks are recognised but they are not properly addressed in every situation and therefore more attention should be paid to the preventive treatment of these risks such as these contracts. Therefore, the first two steps do not need immediate improvement and the third step is questionable.

Also, risk monitoring is an important step in the supplier risk management process. Especially during the current COVID-19 situation, extra attention must be paid to this. Company X has created two files for this purpose, namely the PUR102 and COVID-19 master file. These systems are not entirely effective and therefore need improvement. First of all, there are two important factors to monitor: on-time delivery and on-conformity delivery. In the PUR102, PO lines are only monitored for on-time delivery, in this file, on-conformity delivery must also be monitored. In the second file, the supplier is assessed based on risky PO lines. This is done for a standard number of medium- or higher-risk PO lines but does not take into account the total number of the supplier's PO lines. The results of these files are discussed in the COVID-19 Watchtower. Here, we look weekly at which suppliers need mitigation actions and whether this has been done for the previous weeks. The interviews show that these actions are often not carried out, which means that nothing happens with the entire process. Therefore, this should be monitored more closely.

Figure 9: Problem framework



Source: Invented by author

5 Discussion and conclusion

Conclusion

The previous chapter discussed the results that ultimately lead to the answer to the research question; *How can Company X improve its supplier risk management process to be able to deal with possible pandemics such as COVID-19?* The current supplier risk management process consists of four steps: risk identification, risk assessment, risk management implementation and risk monitoring. Improvements must be made in the area of risk management implementation and especially in monitoring. During COVID-19, Company X set up two files to monitor the risks per PO line. These files must be improved to be more effective in the long term. The improvements that need to be implemented are discussed under the heading practical implications.

This implementation is based on the previous chapter, this chapter revealed several key findings. First, the most important supplier factors to monitor are on-time delivery and on-conformity delivery. These are measured by the Oracle ERP system and via Cognos and are discussed with the supplier on weekly basis. This corresponds with the supplier monitoring theory discussed in Chapter 2. The supply risk categorisation theory can also be recognised in Company X, where these factors are used as selection criteria for the company's suppliers. These are factors such as political guidelines, legislation, financial figures, number of suppliers, obsolescence, product availability and product knowledge. Many of these risks can be covered by executing beneficial contracts. But this is not properly addressed in every situation and therefore more attention should be paid to the preventive treatment of these risks.

Concerning the supplier risk management process described in the theory, Company X follows the same steps, with the emphasis placed on identifying risks and monitoring them during the current COVID-19 situation. Often, the monitoring step is not carried out properly. In the early days of COVID-19, two documents were drawn up as a risk management process in which the probability and impact are indexed (PUR102 and COVID-19 master file), and these results are discussed in a regular COVID-19 watchtower. But these systems are not entirely effective and therefore need improvement. COVID-19 has had the greatest influence on suppliers' delivery times and personal visits by Company X staffers to the suppliers. However, these impacts have not created any major problems for Company X so far. To assess the importance of the supplier risk management categories and the steps in the supplier risk management process during COVID-19, propositions were drawn up in section 2.10. The outcome of these propositions is discussed below

Proposition 1: *The current supplier risk management categorisation is still useful during the COVID-19 crisis.*

Proposition 2: *Risk identification becomes increasingly important within the supplier risk management process during the COVID-19 crisis.*

Proposition 3: *The steps risk assessment, risk management implementation and risk monitoring retain their value and remain useful in the supplier risk management process during the COVID-19 crisis.*

Because the conclusions have been discussed, it is possible to see whether the above propositions are true or can be rejected. Regarding Proposition 1, Company X continues to monitor supplier risk management categories as part of its process. It is even monitored more as more risks occur in these categories due to the COVID-19 situation. This means that the categories are indeed still useful, and the first proposition can be accepted. Regarding Proposition 2, although Company X performs this step well, it becomes more important as more risks appear, so this proposition can also be accepted. This is in line with the statement of Donthu and Gustafsson (2020), who stated that a pandemic outbreak disrupts the supply chain of a company and resilience in the supply chain can be increased by identifying risks.¹⁵⁵ Regarding Proposition 3, risk monitoring becomes increasingly important during the COVID-19 situation, as shown in section 4.3.3. The other steps in the supplier risk management process remain just as important, although Company X does not always provide a useful interpretation of the implementation. Ultimately, the third proposition must be rejected because of the increased importance of risk monitoring.

Limitations

The first limitation lies in the risk identification phase. Everyone in a company is responsible for their own risk and must identify it based on the company's perspective.¹⁵⁶ This means that not every company has the same risks and it may be that some of the risks described in the theory have not been seen as relevant by the respondents. Additionally, Company X has many different purchasing categories in which the risks are varied. If the group of respondents had been larger, more risks might have been identified. Secondly, a thorough literature review was carried out by the researcher. However, due to the increased importance

¹⁵⁵ See Donthu and Gustafsson (2020), p. 288.

¹⁵⁶ See Blackhurst et al. (2008), p. 145.

placed on supplier risk management, a large amount of literature was available. As a result, it cannot be said with certainty that all relevant literature present was examined by the researcher. Furthermore, only recommendations were made for this study and no model was established owing to a lack of time. As a result, it is impossible to determine whether the model works in practice. As a final limitation, the researcher encountered limitations due to the COVID-19 situation, requiring work to be conducted mostly from home and very restricted contact with Company X. As a result, some processes were slowed down and led to a poorer picture of Company X for the researcher.

Theoretical implications

This case study makes a theoretical contribution to the supplier risk management process for supply chains during pandemics. In this process, four steps emerge as the most important ones: risk identification, risk assessment, risk management implementation and risk monitoring. These four steps are particularly important to use during a pandemic but can also be used as standard without a pandemic. The first step is to identify the risk, for which several categories have been established. These categories are divided into the steps supplier risks, market risks and item risks. In the last step, supplier monitoring, additional monitoring of the most important factors and systems and the communication of these to suppliers must take place.

Practical implementations

This research aims to improve the supplier risk management process, which currently is based on the four steps discussed 4.2.2. In the first step, the risks are identified according to the different categories. For these categories, risks are identified, but the implementation is not always carried out properly. Stricter attention must be paid to implementing the right plans.

For the monitoring process, Company X has created two files; Excel files PUR102 and COVID-19 master file. For these files, three recommendations have emerged from the research. Regarding PUR102, only the delivery time is monitored as an impact factor. While delivery time appears to be the greatest risk for most product categories, it does not apply universally. For some products, it is irrelevant whether delivery is much later than planned because the emphasis is on quality. In addition to on-time delivery, another important factor emerged from the research, namely, on-conformity delivery. This quality factor is not

included in the monitoring of the PUR102, perhaps because no problems have been identified yet. However, this may be a factor in later crises. Therefore, the first recommendation is to take quality into account in the PUR102 in addition to delivery.

The PO lines are monitored for each supplier in the COVID-19 master file. If a supplier has a certain number of PO lines scored at a medium or higher risk, this supplier is placed at risk. This is done for a standard number of medium- or higher-risk PO lines but does not take into account the total number of the supplier's PO lines. This means that supplier A, with 500 PO lines of which ten PO lines are medium or higher, is assessed at the same level as supplier B, with 50 PO lines of which ten PO lines are medium or higher. In this case, supplier B is a much greater risk and therefore a more urgent focus than supplier A. It is recommended that Company X consider this impact on a percentage basis, dividing the number of medium- or higher-risk PO lines by the total number of PO lines.

Finally, the PUR102 and COVID-19 master files both indicate whether a risk is mitigated. The interviews and the files reveal that this mitigation is often not followed up, which increases the risks. The final recommendation, therefore, is to plan more time for risk mitigation and to monitor this follow-up more closely.

Future research

This study specifically examined for Company X how the supplier risk management process could be improved for them. This renewed process will also work for other companies in a similar industry. To what extent this will work and for which companies it will work will have to be investigated further. As mentioned in the limitations, the PUR102 model has not been further elaborated for Company X. The next step for Company X is to form this model itself. First, it should examine the weighting of the impact factors of delivery and quality. Next, it must be determined what percentage is used to determine when a quantity of PO lines from a supplier constitutes a risk in the COVID-19 master file. Furthermore, this research is based purely on the knowledge of specialists within Company X itself. For further research, it may be interesting to include the perspectives of the various suppliers.

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Appendices

Appendix 1: Risk categories authors

Supplier risk	(Hoffmann, 2011; Jüttner et al., 2003; Wagner & Bode, 2008; Giunipero & Eltantawy, 2004; Chowdhury et al., 2019; Schoenherr, 2008; Neiger, Rotaru, & Churilov, 2009)
Environmental	(Hoffmann, 2011; Jüttner et al., 2003; Schoenherr, 2008)
Financial	(Hoffmann, 2011; Wagner & Bode, 2008; Giunipero & Eltantawy, 2004; Zsidisin, 2003)
Operational	(Hoffmann, 2011; Chowdhury et al., 2019; Zsidisin, 2003; Neiger, Rotaru, & Churilov, 2009)
Strategic	(Hoffmann, 2011; Wagner & Bode, 2008; Neiger, Rotaru, & Churilov, 2009)
Market Risk	(Zsidisin, 2003; Min, 1994; Kelle & Miller, 2001)
Item risk	(Zsidisin, 2003)

Source: Invented by author

Appendix 2: Supply risk characteristics

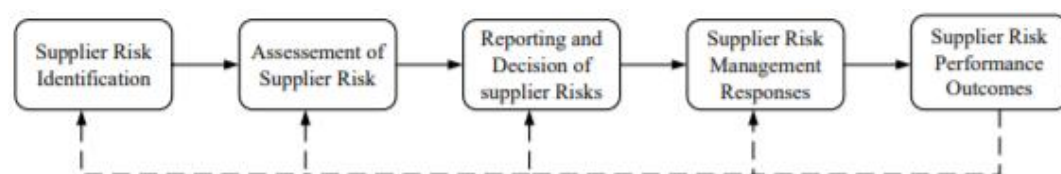
SUPPLY RISK CHARACTERISTICS SUMMARY

	Higher Perceived Risk	Lower Perceived Risk
<i>Item Characteristics</i>		
Impact on profitability	High impact	Low Impact
Nature of product application	New product	Existing product
<i>Market Characteristics</i>		
Global sourcing	Dynamic currency rates, natural disaster regions	Stable currency rates, regions insulated from disasters
Market capacity constraints	Constrained supplier markets	Excess supplier market capacity
Market price increases	Unstable	Stable or declining prices
Number of qualified suppliers	Few	Many
<i>Supplier Characteristics</i>		
Capacity constraints	Limited capacity	Capacity cushion
Inability to reduce cost	Low cost reduction capability	High cost reduction capability
Incompatible information systems	Incompatible information systems	Compatible information systems
Quality problems	Low quality level	High quality level
Unpredictable cycle times	Unpredictable cycle time to meet customer requirements	Predictable cycle times to meet customer requirements
Volume and mix requirements changes	Inflexible; low volume/high mix	Flexible; high volume/low mix

Source: Zsidisin (2003, p. 20)

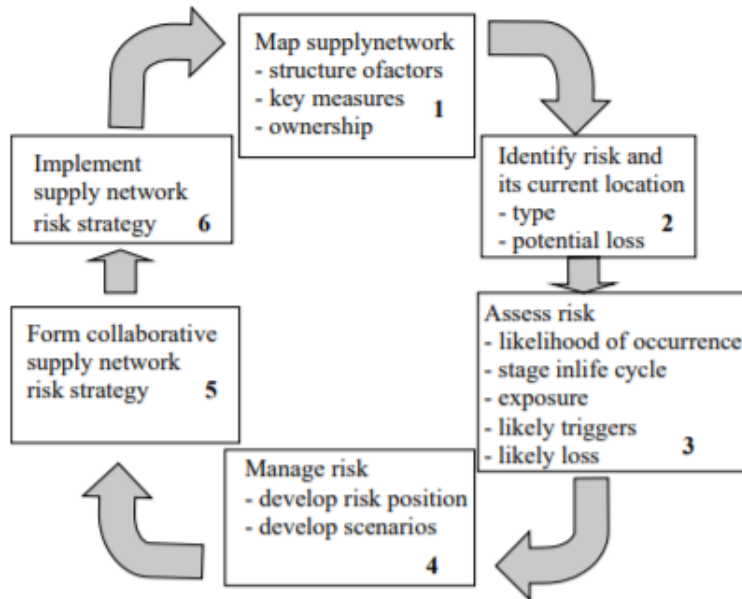
Appendix 3: Supplier risk management frameworks

Framework 1:



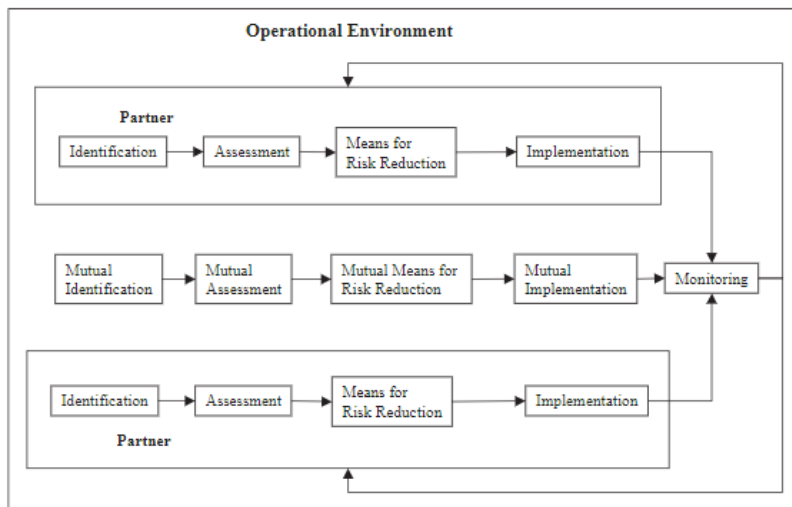
Source: Matook et al. (2009, p. 246)

Framework 2:



Source: Harland et al. (2003, p. 56)

Framework 3:



Source: Hallikas et al. (2004, p. 55)

Framework 4:



Source: Kern et al. (2012, p. 63)

Appendix 4: **Risk management framework comparison**

	Mapping network	Risk Identification	Risk assessment	Reporting and decision of supplier risk	Supplier risk management responses	Manage risks	Risk management implementation	Risk monitoring
(Blackhurst, Scheibe, & Johnson, 2008)	Red	Green	Green	Red	Red	Red	Green	Green
(Hallikas, Karvonen, Pulkkinen, Virolainen, & Tuominen, 2004)	Red	Green	Green	Red	Red	Red	Green	Green
(Matook, Lasch, & Tamaschke, 2009)	Red	Green	Green	Green	Green	Red	Red	Green
(Harland, Brenchley, & Walker, 2003)	Green	Green	Green	Red	Red	Green	Green	Yellow
(Kern, Moser, Hartmann, & Moder, 2012)	Red	Green	Green	Red	Red	Red	Green	Green

Source: Invented by author

Appendix 5: **Interview question list**

Current supplier monitor process

- On which factors does Company X monitor their suppliers? (quality, price etc..)
- Which systems does Company X use to monitor their suppliers?
- How does Company X communicate with their suppliers in the monitoring process?
- How does COVID-19 affect this current supplier monitor process?

Current supplier risk management categorisation

- What are the supplier risks of Company X suppliers?
 - o Environmental
 - o Financial
 - o Operational
 - o Strategic
- What are the market risks of Company X suppliers?
 - o Global sourcing
 - o Market capacity constraints
 - o Market price increase
 - o Number of qualified suppliers
- What are the item risks of Company X suppliers?
 - o Impact on profitability
 - o Nature of product application
- How does COVID-19 affect this current supplier management categorisation?

Current supplier risk management process

- What is the current supplier risk management process of Company X?
 - o Risk identification
 - o Risk assessment
 - o Risk management implementation
 - o Risk monitoring
- Which other components does Company X use in their supplier risk management process?
- How does COVID-19 affect this current supplier risk management process?