1 Introduction to the research

Chapter 1 introduces the research background to present the thematic environment in which the research is conducted. Furthermore, the research gaps in this environment are presented, followed by the derived research objective and the associated research questions. At the end of this chapter, a brief introduction to the methods used and the general structure of the dissertation is given to provide transparency about the research process.

1.1 Research background

In recent years, supply chain risks have emerged in companies across all industries. Examples for these risks include working capital risk, price volatility, or inventory risk caused by e.g. changing demand or supply disruptions due to financial instability, natural disasters or political interference (Galaton, 2019). The increasing vulnerability of the market, triggered for example by external supply chain disasters such as tsunamis or the COVID-19 pandemic (Hong & Kolios, 2020), increases the awareness of companies and the interest in risk management in research. New risks emerged due to increasing technological advances, especially in digitization, and increasing complexity in value creation (Zsidisin and Henke 2019). To create common understanding, international standards define risks as the effects of uncertain events on goals (Deutsche Institut für Normung e.V., 2018). In organizations, a risk can be described as a negative impact on organization´s goals that is associated with damage, loss, or further disadvantages (Li et al., 2016).

Considering this situation and due to significant events around the globe as well as the increasing vulnerability of supply chains (SC), many organizations focused on supply chain risk management (SCRM) (Elzarka, 2013). The literature often refers to the overall risk management process, which is identical to supply-side risk management in the supply chain.. Over the years, a common sense of execution steps has emerged, including (1) risk-identification, (2) -assessment, (3) -mitigation and (4) - monitoring (Aqlan and Lam, 2015; Ho et al., 2015). There are some extensions, modifications, or renaming of these steps. An example is splitting of the risk assessment step (R. Tummala & Schoenherr, 2011) or the addition of further steps (Deutsche Institut für Normung e.V., 2018; International Organization for Standardization, 2009).

From a production perspective, risks that have an impact on stable production supply, such as production failures on the supplier-side or supplier insolvencies (Mwesiumo, Nujen and Buvik, 2021), are particularly important and need to be managed on an appropriate basis. This type of risk, also referred to as “supply risk”, addresses vulnerabilities that occur on the supplier side (Rajesh & Ravi, 2017) and is associated with activities such as purchasing, supplier relationships, and supplier activities (Shenoi et al., 2018).

Risk management and its specified forms, such as SCRM, are already widely used in the literature. Nevertheless, despite the abundance of research, there are some research gaps. (Bak, 2018; Colicchia & Strozzi, 2012; Falkner & Hiebl, 2015; Ho et al., 2015; Sodhi et al., 2012; T. H. Tran et al., 2018) Especially on the level of practice-oriented models, procedures or methods, there is still a lack of literature. Due to limited-time, -investment capital, and -know how, pragmatic

assistance in implementing and executing risk management measures is needed in many organizations.

In addition to pragmatic guidance for each step, data is needed to implement and execute successful risk management. In recent years, the amount of available data has increased rapidly, but the existence of this data and information is not enough to make use of it. The data must be processed, and decisions must be made based on it. Nowadays, processing data can support the value creation of companies in many variations, e.g. by increasing digitization of business processes or company performance. (Becker et al., 2019) Data processing or data use can be interpreted in different ways, so it is important to find a commonly used definition of data processing. Accordingly, the General Data Protection Regulation (GDPR/ DSGVO) defines data processing as any operations, regardless of the degree of automation, that is concerned with collection-, acquisition-, organization-, sorting-, storing-, modification-, changing-, extraction-, requesting-, application-, publication by transfering-, processing or further kinds of supply-, comparison-, linking-, restricting-, deleting-, or destruction-of data (DSGVO, 2016). In general, the proper processing of data holds a very high potential for companies (Schöllhammer et al., 2017), but there is a large gap between the potential of data processing and the actual level of data use. The result of a survey by Nikelowski et al. (2021) confirms the situation of a low level of data processing with 46% of the participants answering that the gap is high or even very high. Several obstacles create a reluctance to data processing even if companies were open to enhanced data processing such as sharing data in the SC. (Nikelowski et al., 2021) To achieve this enhanced data processing, requirements must be developed to create an acceptable environment for data processing.

Particularly in risk management, the potential of digitization can be used to better deal with risks. This is supported by a survey conducted by Seiter et al. (2017) on the impact of digitization on SCRM with the result that 85,9% of respondents agreed that risks will be identified earlier in the future. Furthermore, 84,5% answered that the number of identified risks will also increase and 67,7% agreed on that the analysis of risks will be more accurate. (Seiter et al., 2017) Complementing this survey, Papadopoulos et al. (2017) point to the opportunity to support operational risk reduction through access to a large amount of data (Papadopoulos et al., 2017). In addition to identifying and mitigating risks, risk assessment can also be improved by dealing with this large amount of data (Paal & Hennemann, 2018). Not every position in SC has the same level of data processing. For example, the commerce sector has a much higher level of data processing than the manufacturing sector (Kagermann et al., 2014). Many companies that lack data processing have little knowledge of their own production processes, even if the technologies and methods are already in place. The opportunity in this case is that even small enhancements to data collection can result in large improvements (MPDV, 2016). These are reasons why, for example, the production sector and in particular the supply risks of these companies should be focused on to enable data processing and increase risk management due to the high potential in this environment.

1.2 Research problem and -objective

Nowadays, risk management is gaining increasing interest in research and practice due to the increasing vulnerability around the world. The increasing complexity of SCs is caused for example by globalization, high transportation charges, weather-related disasters, delocalization or terrorist threats (Hamdi et al., 2018). In recent years, many theoretical procedures, steps, or models have been developed to support companies perform risk management. For companies interested in implementing this type of management, the range of possible procedures can be overwhelming. In addition, most advise on the specific focus of risk management steps is based on theoretical- or qualitative-work. Empirical research, especially based on quantitative data, is still fragmentary (Blos et al., 2016), especially with regard to concrete variables that show a success orientation. From the practice perspective, these variables should be considered, e.g., for successful supply risk management. In addition to the lack of practice-oriented risk management support, there is also a lack of data processing, which is important for each step of risk management, starting with risk identification, followed by risk-assessment, -mitigation and -monitoring. Data and information are needed for each of these steps. There are several obstacles for data processing, so companies are not realizing the potential, which also affects risk management. Companies are not always aware of the obstacles, and because they do not know how to assess and deal with them, the obstacles are not mitigated. In terms of SC risks, supplier-side risks are particularly important, e.g., from a manufacturer´s perspective, as smooth production supply is very important. Further, supply risks that occur on the upper side of the SC can have a major impact on all subsequent stages of the chain.

There is insufficient information in the literature on how to implement successful risk management, focusing in this case on supply risks, and how to deal with obstacles in data processing as a basis for risk management.

The purpose of this dissertation is to provide assistance for both topics. For each of the common risk management steps, assistance is provided for individual or more practice-oriented execution. Regarding risk-identification, -mitigation and -monitoring, this dissertation presents specific supply risks that should be focused on, mitigation strategies that should be implemented, and monitoring indicators that should be considered. These variables, divided into necessary- and sufficient-variables for successful supply risk management, were selected from companies already operating successfully in terms of risk management, so that these variables have a practical background based on experienced actors. As with risk-identification, -mitigation and -monitoring, best practices in context of risk assessment, e.g., regarding the presentation of a specific risk level of a potential event, are not appropriate for the assessment of risks, as the maturity of a risk is influenced by the individual situation of a company and should therefore be analysed separately. However, this dissertation also supports risk assessment by providing an application-specific selection procedure for risk assessment methods. This procedure helps to find the most appropriate assessment methods matching the individual needs of a company.

In order to address the lack of data processing, an overview of the existing obstacles and an evaluation procedure is presented. This procedure provides the ability to evaluate the degree of each obstacle in terms of impact on the business and allows for a ranking of obstacles at the end. With this prioritization, organizations can begin to reduce the most painful obstacles to increase data processing, which can also enable and improve risk management. Specifically, this means that the availability of data and its processing enable risk identification to be carried out, as data can create an overview of a company´s current situation, which helps to find risks. Furthermore, risk assessment can be performed using e.g. historical data to choose a quantitative oriented method, which provides a more accurate result in terms of risk level compared to qualitative methods based e.g. only on employee experience. Regarding risk mitigation, reducing data processing obstacles, followed by improved data availability, supports the evaluation of options for managing risks in the future and provides the opportunity to use more data-driven mitigation strategies. In the end, improved data processing enables risk monitoring by requiring specific data to be analyzed, and monitored to continuously track risks.

1.3 Research questions

To address the three main elements of the problem presented in chapter 1.1 and 1.2, this thesis will answer the following research questions.

The focus of the research questions is slightly different. The reason for that is, on the one hand, the goal of focusing on a specific environment, in this case on risks that occur on the supply side to address the supply of companies. On the other hand, solutions are sought that can be applied as universally as possible to increase the generalizability and usability of the research results.

In particular, research question 1 does specifically addresses supply risk management, as concrete variables can be identified for this area for risk-identification, -mitigation and -monitoring. As mentioned in chapter 1.2, this is not useful for risk assessment. This led to the following research question:

1) *Which variables should be focused on in risk-identification, -mitigation and -monitoring to implement a successful supply risk management?*

Research Question 2 seeks to support risk assessment at a different level by addressing a risk assessment method selection procedure. Because this procedure is intended to encompass the assessment outcome requirements that an organization seeks, rather than the specific risk areas, no specification is made so that this procedure can be used in any risk environment. With this approach, it is possible to focus the generalized procedure on the supply risks of a manufacturing company if needed, but it can also be used is for any other situation.

2) *How does an application-specific selection procedure for risk assessment methods can look like?*

As described in chapter 1.3, data processing is closely linked to risk management, as it forms the basis for implementing the individual risk management steps. To support companies establish this

foundation, research questions 3a and 3b are address obstacles to data processing and a procedure for evaluating and prioritizing these obstacles for a company´s individual situation. Since every company is in a different situation and want to expand the use of data in different areas and for different purposes, e.g., to support risk management or to improve processes or transparency, it is not advisable to examine only the data processing obstacles in, e.g., production supply for manufacturing companies. This would severely limit value creation. It makes more sense to identify several existing data processing obstacles and to develop a general procedure to evaluate them independently of a specific use case and to focus the procedure on the individual situation in the execution step. This ensures that the evaluation of data processing obstacles can be carried out e.g. in the environment of production supply, but also in many other areas of SC.

3a) Which obstacles inhibit the data processing in the supply chain down to the manufacturing company level?

3b) How does an application-specific prioritization of obstacles to data processing can look like?

1.4 Research methodology

The research methodology selected for this dissertation is strongly based on the research onion according to Saunders, Lewis and Thronhill (2019). One of the main reasons for this selection is the comprehensive level of detail with which a methodological procedure can be described and classified by this model. Specific methodology characteristics considered in the research are included as onion layers, such as the research-philosophy, -approach and -strategy, as well as the methodological choice and time horizon surrounding the onion core of techniques and procedures. (Saunders et al., 2019) Additionally, research-ethics, -reliability and -validity are described as important aspects of scientific work. Each of the key methodological characteristics is further subdivided based on its orientations. The detailed breakdown of the methodology supports transparency about the research procedure of this dissertation as well as the validity of the research findings. Several common strategies are mentioned in the onion layer of the research strategy, which does not necessarily constitute the pool of methods that must be used. Since some of the research in this dissertation follows a type of design science research strategy, it is added to the examples already mentioned. As mentioned in the research questions in chapter 1.3, this dissertation addresses three research topics, all of which contribute to a successful entry into risk management with a focus on company supply. Since these research topics partly follow different methodological orientations, a subdivision is made between in the methodological chapter. Chapter 3 provides a detailed insight into the subdivisions of each research onion layer and describes which of them is most suitable for the present study.

1.5 Research structure

Chapter 1 provides a brief introduction to the relevant topics of this dissertation, beginning with a brief literature background. Furthermore, the research-problem, -objective, research questions, -methodology and - structure are presented. Chapter 2 provides a detailed look at the literature on

the overall environment of risk management in the SC and focus on supply risk management. Further, the common steps of this type of risk management are presented and different types of risks used within this dissertation are explained. Since the environment of data and its processing is also important to this research, these topics are included and linked to general risk management. Chapter 3 describes the methodology used in this research, including several subchapters such as research-philosophy, -approach, -strategy, -ethics and -reliability, as well as the time horizon, methodological choice and techniques and procedures that comprise the research methodology. Chapter 4 is the main body of the dissertation. As shown in Figure 1, the research is divided into three research areas. As indicated in subchapter 1.4, the three research orientations are Research A, which addresses the necessary- and sufficient-variables for successful supply risk-identification, -mitigation and -monitoring, Research B, concerning risk assessment and Research C dealing with obstacles for data processing. These orientations and their associated letters (A, B, C) will appear several times throughout this dissertation. Chapter 5 is the validation chapter. For Research A, this chapter includes the validity test of the data set used, which was generated by the pre-executed survey by the University of Twente. Since the determined variables for supply risk-identification, -mitigation and -monitoring have already been evaluated through a dissertation-external survey with 179 participants, the results do not require further validation. Research B and C are validated through a case study in collaboration with a company to test whether the developed procedures work and to find opportunities for improvement. This validation is described in detail in Chapter 5. The final substantive chapter is Chapter 6, which summarizes the entire research and draws a conclusion, as well as presents the research limitations and recommendations for future research. In the end the references used and the appendix is added. The explained structure for this thesis is summarized in a visualized manner in Figure 1.

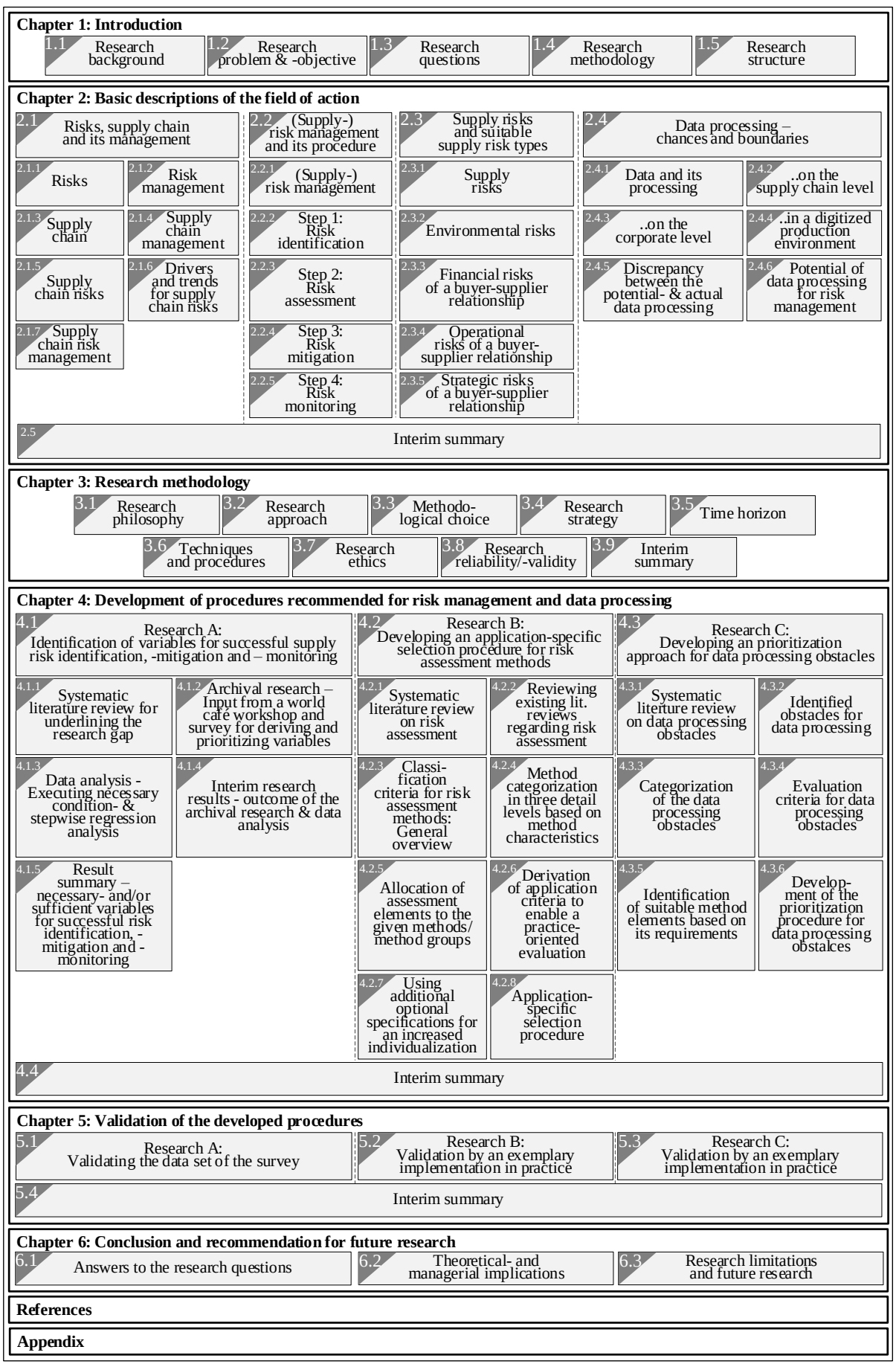

Figure 1: Research structure