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Supply Chain Risk Management in Crisis Situations

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Purpose: *The aim of the paper is to develop a concept for implementing supply chain risk management (SCRM) in crisis situations based on recommendations for action.*

Methodology: *The paper utilizes a mixed-method approach based on a systematic literature review and an interview study to analyze the state of research and practice in order to extract the recommendations for action.*

Findings: *The insights gained from the analysis of existing approaches and the findings from the expert interviews are incorporated into the development of the concept. This includes general recommendations for implementing a SCRM as well as specific measures for preparing for and managing crisis situations.*

Originality: *The concept is intended to support companies in implementing a suitable SCRM system that supports a systematic improvement in the resilience of companies with regard to risks and crises and forms the bases for effective crisis management.*

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1 Introduction

Companies have been facing various megatrends for more than a decade: Globalized markets, rapidly changing technologies, shorter product life cycles, and the shift from a seller's market to a buyer's market are creating more volatility and uncertainty in the marketplace (cf. Abele and Reinhart, 2011, 10ff.). For years, these trends have been causing companies to rethink their operations and to join forces in supply chains. As a result, it is no longer individual companies that compete with each other, but entire supply chains (cf. Christopher, 2011, pp. 15–16). The task of supply chain management in this context is to achieve the most cost- and time-optimized cooperation possible between the companies involved.

Interruptions and disruptions in the supply chain not only affect the acutely affected organization due to the close interconnectedness of the companies, but can also result in financial losses and reputational damage for other organizations in the value network (cf. Jüttner, 2005, pp. 120–121). The strong focus on efficiency in the context of supply chain management, which goes hand in hand with the reduction of buffer stocks in line with the lean philosophy, is increasingly making supply chains more vulnerable (cf. Kersten, et al., 2011, p. 153). An amplification of the risk of potential supply chain failure or breakdown is evident at the global level, as global supply chains are influenced by a variety of country-specific factors. In this context, the effort and difficulty of management increases enormously, however, this can be justified by access to cheaper labor, raw materials as well as other incentives of different locations (cf. Manuj and Mentzer, 2008a, p. 134).

Due to the high level of uncertainty and associated risks in global supply chains, it is of paramount importance for companies to understand the range of potential risks and their interconnectivity in order to establish appropriate risk mitigation strategies (cf. Manuj and Mentzer, 2008b, pp. 192–193). The volatile market situation prevailing today justifies the classification of supply chain risk management as a discipline of very high priority for both practitioners and academics.

Nevertheless, risk management is not or not sufficiently practiced in many companies. A study by management consultants INVERTO shows that only 38% of the companies

surveyed systematically record and assess risks (cf. Jüttner and Maklan, 2011, p. 246; INVERTO GmbH, 2020, p. 5). Crisis situations in particular, such as the current global COVID-19 pandemic, clearly show the vulnerability of companies and their supply chains (cf. Kersten, Schröder and Nagi, 2022, p. 744). For example, in June 2021, 38% of respondents to a survey by the Austrian Association of Materials Management, Logistics and Purchasing perceived supply chain disruptions as an impact of the Corona crisis, and 19% spoke of a disrupted supply chain (cf. BMÖ, STÖHR FAKTOR Unternehmensberatung GmbH and ISM, 2021, p. 6).

The aim of this paper is to develop a concept for implementing supply chain risk management in crisis situations based on recommendations for action. The concept is intended to support companies in implementing a suitable supply chain risk management system that supports a systematic improvement in the resilience of companies with regard to risks and crises and consequently forms the basis for effective crisis management.

To achieve the defined objective, the following research question will be answered: How can supply chains be prepared for and successfully managed in the context of crisis situations?

The structure of the paper is as follows: Section 2 first reviews the general theoretical background of supply chain risk management (SCRM), supply chain resilience (SCRES), and crisis management. Then, Section 3 presents the methodological approaches for the literature review and analysis and the interview study. Afterwards, in Section 4, the core findings of the literature review and analysis and the interview study are brought together to present the developed concept based on them. Section 5 summarizes the findings and offers an outlook on possible areas for further research.

2 Background

2.1 SCRM

Supply chain risk management (SCRM) represents a combination of the classic approaches to risk management with supply chain management (cf. Kersten, Schröder and Indorf, 2017, p. 53). Compared to the classic company-based risk management approach, SCRM as an interorganizational approach differs primarily in its cooperative risk handling with the participation of several supply chain members (cf. Jüttner, Peck and Christopher, 2003, pp. 200–201; Kajüter, 2003, p. 111; Tang, 2006, p. 453; Rao and Goldsby, 2009, p. 101). According to Kajüter (2003, p. 111), interorganizational risk handling entails the following special features for risk management in the supply chain context:

- Two levels of action exist with the companies and the supply chain.
- There are information asymmetries with regard to risks between the individual companies and the supply chain.
- The individual organizations usually pursue different risk strategies.
- Companies are often involved in several supply chains and are therefore limited in their willingness to adapt to individual supply chain standards.
- International supply chains must meet different national regulatory requirements for risk management.

A large number of definitions for the term SCRM can be found in the business management literature, which differ in terms of the scope and objective of the concept (cf. Sodhi, Son and Tang, 2012, p. 8). This paper is based on the definition of Kersten, et al. (2007, p. 1171) according to which SCRM is defined as a "*[...] a building block within supply chain management that encompasses all strategies and measures, all knowledge, all institutions, all processes, and all technologies that are suitable at the technical, personnel, and organisational levels for reducing risk within the supply chain*" (Kersten, et al., 2007, p. 1171).

Collaboration in the context of SCRM is based on two different endeavors: The sharing of risk-related information between supply chain partners and the collaborative management of supply chain risks (see Jüttner, 2005, p. 132; Kleindorfer and Saad, 2005,

p. 66; Li, et al., 2015, p. 84). Sharing information between supply chain partners reduces uncertainty in supply chain management and leads to improved visibility within the supply chain (cf. Chen, Sohal and Prajogo, 2013, p. 2195). The improved visibility and reduced uncertainties also allow companies to stockpile lower safety stocks (cf. Christopher and Lee, 2004, p. 391). The effectiveness of sharing risk-related information is significantly influenced by the duration of the relationship and the level of trust between the supply chain partners involved (cf. Li, et al., 2015, p. 89). Supply chain risks usually result from common processes or the relationship between companies or affect multiple companies in the supply chain (cf. Jüttner, 2005, p. 132). Based on this, these risks are classified as joint risks and risk handling is coordinated accordingly using the capabilities of multiple supply chain partners (cf. Chen, Sohal and Prajogo, 2013, p. 2195). The goal of collaborative risk handling is to make SCRM as effective as possible, but also efficient, in order to maximize and fairly share the value and benefits generated in the supply chain (cf. Kleindorfer and Saad, 2005, p. 66).

The selection of the approach to be followed depends to a large extent on the type of business relationship between the companies in the supply chain. The importance of the business relationship and the phase of network formation are determining factors. In early phases of the network formation the close and trusting co-operation necessary for an enterprise-spreading SCRM is often not yet given, so that in such situations a risk management in the procurement can prove quite effective. With increasing intensity and experience in co-operation this beginning can be developed then further. The parallel pursuit of the approaches within a supply chain is possible, since the decision of the approach is always based on the individual business relation between the partners (see Kajüter, 2003, pp. 116–117).

Nevertheless, companies should aim to design the SCRM process cooperatively with their supply chain partners and thus extend risk identification, analysis and evaluation as well as risk management to the entire supply chain.

In addition to SCRM, the concept of supply chain resilience has also been increasingly discussed and researched in the literature for several years in connection with risks in value networks (cf. Pettit, Croxton and Fiksel, 2019, pp. 57–58).

2.2 Crisis Management

The term crisis is frequently used in everyday language as well as in science, but the ambivalent character of the term is often neglected, especially in the context of non-scientific use (cf. Radowski, 2007, p. 13). In science, on the other hand, the term is interpreted interdisciplinarily as a threat to existence with the possibility of positive as well as negative development (cf. Krystek and Lentz, 2014, p. 33). The term crisis can be generally defined as "*a serious threat to the basic structures or the fundamental values and norms of a system, which under time pressure and highly uncertain circumstances necessitates making vital decisions*" (Rosenthal, Charles and 't Hart, 1989, p. 10). A variety of causes can bring about crises (see Grewal and Tansuhaj, 2001, p. 68; Krystek, Moldenhauer and Angster, 2007, p. 24). A distinction is often made between system-internal and system-external, but also between natural and man-made causes of crises (cf. Rosenthal and Kouzmin, 1997, p. 280; Krystek, Moldenhauer and Angster, 2007, p. 24).

According to the definition by Rosenthal, Charles and 't Hart (1989, p. 10), uncertainty, urgency, and danger are central properties of crisis situations. According to Krystek and Lentz (2014, pp. 33–34), crises can also be characterized by the following properties (see also Krystek, Moldenhauer and Angster, 2007, pp. 26–27):

- Threat to existence
- Ambivalence of the outcome (annihilation or coping)
- Temporal limitation
- Limited ability to influence
- Progressive loss of possibilities for action

Accordingly, crisis management can be understood as a systematic approach to the prevention of crises and the effective handling of crises that do occur (cf. Pearson and Clair, 1998, p. 61). This definition suggests an active or preventive approach and a reactive approach to handling crises (see Figure 1). In this context, crises can be seen as the occurrence of risks that threaten the existence of the company, so that the identification, assessment and avoidance of potential crises and thus active crisis management are largely covered by risk management (see Fiege, 2006, pp. 194–196). Preventive crisis management also carries out planning and preparations in the event

that a risk cannot be controlled within the framework of risk management (cf. Töpfer, 2006, pp. 377–378). Reactive crisis management (also crisis management in the narrow sense) acts on a case-by-case basis when risks occur that could not be controlled within the framework of risk management and have an impact on the company's objectives that threatens its existence (cf. Fiege, 2006, p. 194). In response to an event occurring, individual and organizational readjustments of basic assumptions as well as recovery and readjustment reactions are required for effective crisis management (cf. Pearson and Clair, 1998, p. 66).

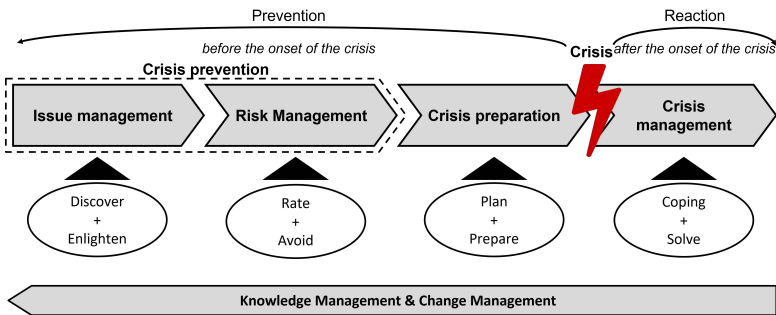


Figure 1: Process diagram of crisis management (own representation based on Töpfer (2006, p. 378))

3 Methodology

In order to answer the underlying question, the authors conducted a literature review and analysis with the aim of systematically collecting and presenting a comprehensive overview of the relevant scientific approaches to crisis management in supply chains. At the same time, however, approaches located in the practice of companies are also to be considered in order to identify the current state of knowledge both in the field of research and in corporate practice.

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In the following step, the influence of the integration of SCRM on the resilience of companies and the role of digital tools as well as collaboration in industrial practice will be discussed in this context within the framework of an interview study.

3.1 Systematic Literature Review

In phase 1, starting from the research question, an unstructured online search is first conducted using broad search terms to find important literature in the topic area under investigation (see Figure 2). The aim of this procedure is to compile an initial set of relevant literature for the field of investigation. For this purpose, the works identified as relevant are examined for references to further relevant literature. Based on this compilation, important keywords and formulations in the considered field of investigation can be derived subsequently.

Phase 2 focuses on the selection of databases. Here, a distinction is made between the selection of databases for scientifically published literature and databases for grey literature. The identification of suitable databases for scientific literature is mainly based on the initial literature, on the basis of which different databases are tested for the availability of relevant literature. As a result of this step, the electronic databases SCOPUS (www.scopus.com) and Web of Science (www.webofknowledge.com) are selected, which in combination offer a broad coverage of the potentially relevant literature and also allow a tabular export of the data. For the identification of relevant grey literature, the Google search engine (www.google.com) is selected, since due to the topicality of the research field in the context of the pandemic, the broadest possible base of grey literature should be searched.

In phase 3, a list of search terms is derived based on the keywords and formulations obtained from the initial literature. First, possible terms are collected and supplemented with alternative spellings and potential synonyms. Subsequently, the collected terms are divided into thematic groups, so that from now on combinations of term blocks can be tested as search queries on the selected databases. When testing the potential queries on the SCOPUS and Web of Science databases, two primary criteria are used to evaluate the search queries: The number of hits and the ratio of relevant to irrelevant hits. A very large number of hits may indicate that the search request is too broad and that further

processing is very time-consuming. If, on the other hand, the number of hits is rather small, it may be that the search request is too specific and that complete coverage of the relevant literature is not achieved. The ratio of relevant to irrelevant hits for the field of investigation can be tested on a sample basis. However, both evaluation criteria leave some discretion, so testing is an iterative process. This approach applies to scientific databases.

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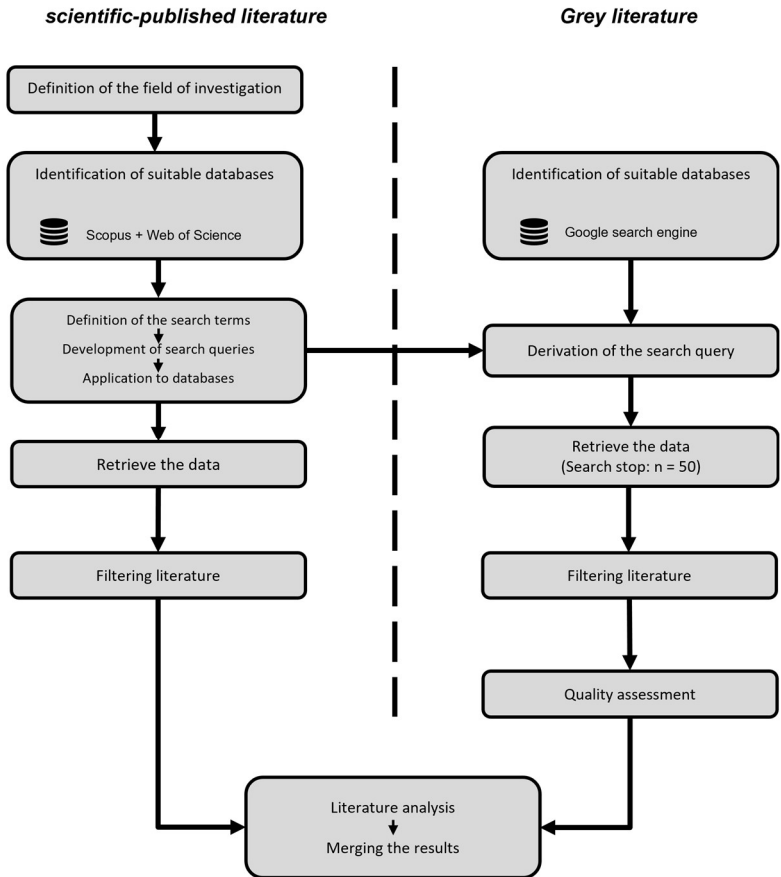


Figure 2: Flow of structured literature review and analysis (own representation; phases based on Fink (2014, pp. 3–5) and Garousi, Felderer and Mäntylä (2019, p. 108)).

For the search request for data collection of grey literature by means of a search in the Google search engine, the search requests of the scientific databases are used and

reduced accordingly to the most concise and most frequently used search terms. The individual search queries in the respective syntax of the databases are shown below.

Table 1: Search queries in the respective databases (own representation)

SCOPUS	TITLE-ABS-KEY ((crisis OR disaster) AND ("supply chain" OR "supply network" OR "SCM" OR "SCRM") AND "risk management") AND (LIMIT-TO (LANGUAGE, "English") OR LIMIT-TO (LANGUAGE, "German"))
Web of Science	(TS=((crisis OR disaster) AND (“supply chain” OR “supply network” OR “SCM” OR “SCRM”) AND “risk management”)) AND LA=(English OR German)
Google-search engine	supply chain risk management crisis

In the search queries of the databases SCOPUS and Web Science, synonyms or terms of a topic group are linked with the logical operator "OR" and different topic groups with the operator "AND". The search is applied to title, abstract and keywords and limited to German and English language literature. In the context of the search for grey literature, the use of logical operators is avoided. The searches were applied to the previously selected databases and resulted in 319 hits in the SCOPUS database and 136 hits in the Web of Science database. The search for grey literature is limited to 50 results declared as the most relevant hits by the Google search engine algorithm. Thus, the three databases provide a cumulative total of 505 hits, whereby in the subsequent filtering (phase 4), due to the special handling of grey literature, the hits from the scientific databases (SCOPUS and Web of Science) are considered separately from the hits from the Google search.

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In phase 4, the literature lists generated from the queries of the databases are filtered for scientific and for grey literature. The order of the filtering stages is largely identical, apart from the fact that the assessment of the relevance of grey literature can in part only take place in the context of a full text analysis due to the lack of a standardized form (cf. Adams, Smart and Huff, 2017, p. 434). In the first filtering stage, duplicate and incomplete hits are obviously sorted out. Subsequently, in filtering stage 2, duplicates are identified that are in the hit list due to partial overlaps of SCOPUS and Web of Science. Subsequently, in filter stages 3 and 4, hits relevant to the field of investigation are filtered out using filter criteria in the context of title and abstract screening. In order to be considered in the literature analysis, the works must firstly have a reference to supply chains and secondly address the management of crises in the broadest sense. Furthermore, articles are excluded in this step which, in the context of the title or abstract screening, show a very strong specialization with regard to the industry or risk type under consideration, so that the results obtained do not have any general validity. The resulting list of relevant literature is subjected to a full text analysis in step 5 in order to finally filter out the relevant approaches to the management of supply chains in crisis situations.

The peculiarities in the handling of grey literature are, in the context of filtering the literature list, on the one hand, the compulsory full text analysis for some works due to the lack of meaningfulness of the titles or abstracts, if abstracts are available. On the other hand, the literature identified as relevant cannot be included in the literature analysis (phase 5) without prior quality assessment. For this reason, the identified works are examined with regard to their quality using an evaluation form based on Garousi, Felderer and Mäntylä (2019). For this purpose, each work is evaluated with regard to 19 criteria/questions. If the evaluation is positive in terms of quality with regard to the respective criterion/question, the work receives one point. For the inclusion of grey literature in the literature analysis, a minimum score of ten out of 19 possible points is required. The approved works, as well as the identified relevant works from the defined scientific databases, are subsequently analyzed in more detail in phase 5.

In phase 5, both scientific works and works that can be classified as grey literature are analyzed and processed in order to reflect the state of research, but also current practice.

For this purpose, the identified works were examined in terms of content and qualitatively systematized.

3.2 Interview study

In addition to the systematic literature review, expert interviews were conducted to answer the research question. In the interviews, in addition to the handling of the SCRM process in practice, collaboration and digital tools and, finally, SCRM in the Corona pandemic were discussed.

For the evaluation of the expert interviews, content-structuring qualitative content analysis was carried out according to the approach of Mayring (2015). The focus of content analysis according to Mayring is a system of categories derived from theoretical assumptions and developed on the material, which determines the aspects to be filtered out of the materials (cf. Mayring, 2016, p. 114). For this purpose, categories were determined deductively from the research question and the interview guide in the present research project, which were supplemented by categories derived inductively from the material. In the context of interpreting the data, Mayring (2015, p. 67) distinguishes between three different basic forms: Summary, Explication, and Structuring. This article is based on a structuring summary of the content of the data collected in the course of the expert interviews (cf. Mayring, 2015, p. 103).

The data collection of the nine expert interviews took place in May 2021. Prior to this, contact was made by e-mail or LinkedIn and, if necessary, subsequently by telephone. The vast majority of the interviews took place via online video telephony using the Zoom software tool, and one interview was conducted by telephone. The duration of the interviews ranged from 31 to 60 minutes, and on average an interview lasted approximately 45 minutes. To prevent loss of information, the interviews were allowed to be digitally recorded, with the exception of the telephone interview. During the telephone interview, a transcript of the interview was made by the interviewer.

The transcription of the interviews is indispensable for a detailed analysis of the data (cf. Gläser and Laudel, 2006, p. 193; Meuser and Nagel, 2009, p. 476; Mayring, 2016, p. 89). For

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this reason, verbatim transcripts were created using the audio recordings of the interviews.

Table 2: Overview of interview participants (own representation)

Interview	Position	Industry
1	Head of Logistics Controlling	Heating Systems
2	Supply Chain Manager	Aircraft
3	Head of Sales	Software/IT
4	Head of Supplier Risk Management	Automotive
5	Solutions Design Manager	Logistics
6	Head of Advanced Purchasing	Mechanical Engineering
7	Senior Vice President – Strategic Procurement & SCM	Mechanical Engineering
8	Partner	(IT-) Consulting
9	Procurement – Head of Strategic Projects	Heating Systems

The evaluation is based on a category system whose categories were determined deductively from the question and the topics of the interview guide as well as inductively by reading the interview texts. In the context of this evaluation, individual sentences are used as the smallest material components for category assignment and paragraphs as the largest material components for category assignment. The individual interviews each represent a unit of evaluation. The evaluation is first conducted using the deductively derived initial evaluation grid and structures the content by assigning it to main categories. Based on the text work, the evaluation grid is extended and refined by further (main) categories. The final analysis process is carried out with the final evaluation

pattern/category system. The main categories considered are the following: SCRM in Practice, Collaboration, Digital Tools, Crisis Situations, and Corona Pandemic.

4 Concept Development

In the following section, the findings obtained in the course of the structured literature review and analysis as well as the expert interviews and the qualitative content analysis are combined and transferred into a concept for SCRM in crisis situations. Within the framework of the concept, recommendations for companies on how to prepare supply chains for crisis situations and how to manage them when such situations arise will be presented in line with the underlying research question. For this purpose, the identified state of practice will first be briefly summarized in order to then present the concept with recommendations for action on the basis of the core findings obtained.

In practice, the integration of SCRM often takes place in the individual departments of companies, such as logistics, purchasing, production, etc., and focuses the risk assessment on the respective department (Interview 1, 2, 6, 7, 9). A consolidation of the different information and perspectives on the risk situation in the supply chain is rarely part of the implemented SCRM (Interview 3, 8). SCRM tasks are mostly the responsibility of employees who perform these tasks only as a limited part of their role in the company. These employees are thus often experts in the respective field, but in some cases have only limited expertise and experience in the area of risk management (Interview 4, 6, 9). Based on this, many companies lack a systematic process approach to SCRM (Interview 3, 4, 6, 8). The lack of interdepartmental information exchange and a non-systematic approach can result in limited visibility of risks in the supply chain in companies, which can lead to late detection of risk-related crisis situations. Similarly, due to the lack of systematization of the SCRM process, manual updating of risk data is often irregular (Interview 6, 9). In addition, the existing supply chain structures are often designed to achieve efficiency goals, so that single-source solutions are also often implemented to achieve volume effects, which, depending on the type of crisis situation, harbor particularly large risk potentials with regard to the company's security of supply (Interview 3, 5, 9). Crisis situations in companies, and particularly in the area of supply

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chain management, are often not considered by means of proactive measures, but only reactive ones (interview 3, 5, 8). One measure primarily used in this context in practice is the buildup of buffer stocks to secure supplies (interview 1, 7, 9).

There are considerable differences between the state of practice identified and the information obtained on approaches and options for SCRM in crisis situations. However, using the example of the corona-pandemic, it can also be noted that general recommendations for action of specific measures to address crisis impacts are not possible. The impact of the coronal pandemic on companies is highly dependent on the company's industry and the products or services it sells, as well as the company and supply chain structure. Thus, some companies may benefit from the same crisis events that threaten the existence of other companies. Furthermore, no "classic" crisis situation can be characterized, as the influences can be multidimensional and affect companies in a wide variety of ways. Nevertheless, on the basis of the core findings (CF) presented below from the structured literature review of scientific and grey literature as well as the analyzed expert interviews, various recommendations for action can be derived for corporate practice. These reflect general strategies and measures for strengthening the company's resilience with regard to crisis situations.

CF 1	SCRM forms the basis for SCM in crisis situations; however, it is not possible to fully capture crisis situations within the framework of the classic SCRM process.	CF 5	Integrating a systematic SCRM approach into corporate structures allows for building increased organizational resilience.
CF 2	Building flexibility and redundancy is a critical element of supply chain resilience to crisis situations.	CF 6	Transparency, flexibility and a risk-conscious culture are elementary factors of corporate resilience.
CF 3	Supply chain collaboration is a helpful element for both crisis identification and crisis management.	CF 7	Digital tools have the potential to enhance the positive effects of SCRM and allow for simplified handling of the process.
CF 4	Modern technologies offer companies the opportunity to manage crisis situations faster and more effectively, especially through monitoring processes and simulations.	CF 8	Collaborative SCRM takes place in industrial applications only to a very limited extent, but it offers the potential to function as a key factor and competitive advantage with regard to crisis situations as well as in the context of normal competition.

Figure 3: Core findings of the preceding research methods (own representation)

Due to the fact that crises, as already described, can occur for companies in a variety of characteristics and can influence the supply chain, the recommendations for action are based primarily on preparatory activities in the area of SCRM. For this reason, the recommendations for action largely present generally applicable measures and strategies for preparing for crisis situations and largely dispense with specific approaches to specific risk situations. These must be adapted to the structure, risk strategy and type of risk in the respective company. Furthermore, approaches and options are presented within the framework of reactive crisis management, which take into account adjustments within the framework of this special situation for SCRM. Again, specific recommendations for action are not provided.

The recommendations for action described below are aimed at strengthening the resilience of the respective company and implementing strategically important factors for managing crisis situations. In essence, the concept aims to achieve the following goals in the course of crisis management:

- Avoidance of crises if possible
- Early identification of crisis situations
- Detailed view of the supply chain and its structures (visibility)

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- Flexible options for action
- High reaction speed

The recommendations for action described below are therefore not only suitable for crisis situations, but also represent generally applicable measures for implementing effective SCRM. The concept describes five interlocking sub-areas that enable adequate crisis management of supply chains: SCRM, digitalization, SCRES, collaboration and reactive crisis management (see Figure 4). While reactive crisis management addresses the actual crisis situation, the other four areas act in preparation for the avoidance, limitation or management of crisis situations.

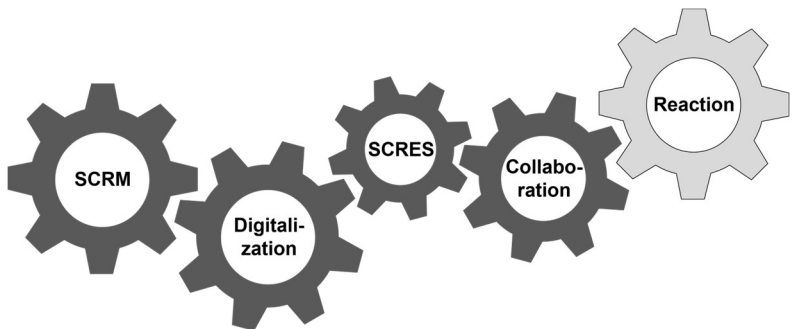


Figure 4: The five sub-areas of effective supply chain crisis management (own illustration)

The recommendations for action within the framework of the preparatory sub-areas of supply chain crisis management are presented below (see Figure 5). It should be noted here that the first three areas in particular build on each other and are interwoven, so that the greatest possible effects for companies can only be achieved by implementing all areas. For this reason, the recommendations for action presented in the concept are based on the interaction and use of SCRM, digitization and SCRES. Collaborative SCRM (presented as Collaboration) once again occupies a certain special position here, since the internal mastery of SCRM in the form of the aforementioned areas should in principle be regarded as a prerequisite for the application of this cross-company approach.

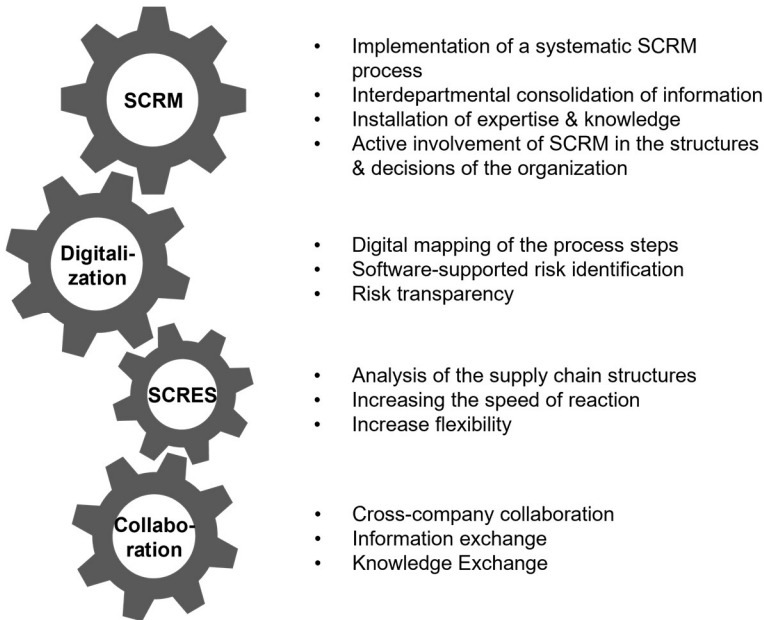


Figure 5: Preparatory measures (own representation)

The basis of the concept is SCRM and its organizational integration. To this end, companies should implement a systematic SCRM process in the specialist departments of the supply chain (e.g. purchasing, logistics, production, quality management, sales, etc.). The information from these processes should be combined across departments in order to exploit synergy effects and possibly implement measures jointly. The goal is to increase the effectiveness and efficiency of the processes by allowing all departments to benefit from a better information situation and to avoid measures with negative effects on other departments of the company. For this purpose, the digital mapping of process steps is advantageous, as this allows all information to be brought together digitally and made accessible to the relevant persons or employees. In this way, the company actively promotes the internal exchange of information and ensures transparent documentation of the risks and measures as well as the underlying processes. With the help of these

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measures, SCRM or risk management in general should be actively integrated into the structures and decisions of the company in the next step in order to establish a risk-conscious culture among all employees of the company. In the course of this, it is of great importance, especially with regard to crisis situations, to implement clear structures for decision-making as well as an awareness of the need for fast decision-making processes in crises within the company

In order to install the SCRM process in the individual departments and bring it together effectively at the corporate level, companies need to establish knowledge and expertise in the necessary places. This means that it is necessary to train and educate the respective employees with regard to risk management, as they are mostly experts in the relevant area of the specialist department. Here, if available, the company's risk management departments can provide support in terms of methods and processes and define cross-departmental risk management standards. The expertise of the relevant employees supports the effective implementation of the systematic process and also promotes its continuous improvement. The process itself is classically divided into the phases of risk identification, risk analysis and assessment, and risk monitoring

In the context of risk identification, risk scenarios should be considered, which can be discussed with the help of creative techniques, such as brainstorming, and discussed in teams. Here, schemas with risk categories and potential risk events can serve as input to support the process. On the other hand, the structures of the supply chain should also be analyzed for potential vulnerabilities and the individual supply chain links for their stability. In this case, too, the use of schemas of possible loss events can be helpful. External data, such as that from insurance companies or credit institutions, should also be used to identify possible vulnerable or unstable links in the supply chain. In the course of digitization, this process step can be simplified and made clearer for companies by digitally mapping the supply chain. In addition, AI-supported tools offer the possibility of automatically merging large amounts of data from external sources, making it clearly accessible to employees and updating it on a regular basis. Especially in the case of complex global supply chains, which are to be mapped beyond Tier 1 partners, this type of tool offers an enormous simplification of the process and has a strong positive impact on transparency and visibility.

The assessment of risks should consider on the one hand the probability of the risk event, but also the impact of the event occurring. The probability can be determined by external data or by expert estimates within the team. When determining the impact of the risk event, companies should avoid using only the damage caused by the event. Rather, the assessment should consider both quantitative and qualitative factors. A quantitative factor could be, for example, the impact on sales or on the operating result of the company, which in the case of supplier failures can be calculated with the help of bill of materials data, but also automatically using digital tools. These quantitative metrics may be more suitable than the loss amount for certain risks, as they already take into account possible coverages of the risk event by insurance companies. Other factors that can be considered include, for example, the detection period of the risk occurrence, the duration of the risk event, or the time it takes to restore full performance. As part of a qualitative consideration, the company's affected products can be analyzed (Is the core business negatively impacted or is it a niche business?) and in the case of supplier risks, it may be advisable to consider the relationship with the supplier (Is it a strategic partner of the company?). These assessments should be based on the expertise of the respective specialist department and allow partial inclusion of non-monetary damage components (e.g., reputational damage). The assessment should always take into account measures already implemented and be based on data and company-specific expertise. In the case of risk impacts that are difficult to derive, the use of scenario analysis can be helpful as part of the assessment and provide valuable information for risk treatment.

Risk treatment is based in part on the application of the five classic strategies: avoidance, mitigation, limitation, pass-through, and acceptance. Furthermore, however, it should also focus on strengthening resilience (SCRES) and explicitly building flexible capacity to limit or reduce the impact of unpredictable risk events. The goal of this is to safeguard potentially vulnerable points in the supply chain. Potential measures in this area include the qualification of personnel for various activities, the establishment of second-source suppliers with contractually defined flexible capacities, short-term contract terms, flexible capacities at logistics service providers, and the differentiation of supplier locations to limit the influence of local risks or crises. In addition, reducing the complexity of supply chain structures can be considered to increase the visibility of the company.

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For specifically defined risk scenarios, it is a good idea to develop business continuity plans so that pre-planned measures can be initiated in the event of occurrence. A strategy that aims to build up redundancies can also be implemented, but this must be analyzed and assessed in detail beforehand in terms of its impact on the company's liquidity, especially with regard to crisis situations. In addition, it should be taken into account that strategies such as the classic range increase through buffer stocks may be subject to a time limit in terms of their effect.

The measures implemented as well as the assessment of risks should be reviewed on a regular basis. To this end, it is necessary to carry out a cyclical update of the data on which the risk assessment and thus also the strategy derived from it are based, and to make a new assessment of the situation. A need for action is then derived on the basis of the results. For example, a visualization based on the traffic light colors is suitable for displaying the current status of the respective risks and the urgency of possible actions in a simplified manner. As already mentioned, updating the data can be facilitated by the use of digital tools.

Once the recommendations for action described above have been successfully implemented and consolidated in the company, an expansion of SCRM to the cross-company level can be considered. For this, however, it is necessary to first define the relationship with the respective partner, as companies should assess the type of cooperation with other companies based on the trust placed in them, the underlying dependency and possibly different business strategies. Companies can and should cooperate with different companies within their supply chain in different ways and with different intensity. Once the type and intensity of collaboration is determined, cross-company SCRM initiatives can be launched. In its simplest form, this can take place in the context of knowledge exchange, for example in the course of supplier development programs. The goal of this is to benefit from the different expertise in the partner companies in order to increase the profitability of the individual companies. A further step could be the implementation of a formal process of information exchange between the companies in order to improve the information base and thus also the basis for the companies' decision-making. The final step of collaborative SCRM also includes the joint

development and implementation of risk treatment measures. The basis for all forms of collaborative SCRM is the general cooperation and mutual trust of the partners.

In the event of a crisis occurring, only a few general recommendations for action can be derived due to the diversity of characteristics of such situations. Important elements of successful management of supply chains in crisis situations are shown below (see Figure 6).

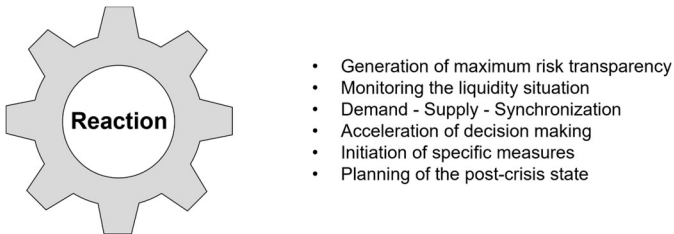


Figure 6: Reactive crisis management (own representation)

The basis for all action in such situations is a solid information situation across all departments of the company, as crises can have a wide range of effects on different areas of the company. For example, supply chains and thus supply can be threatened, but at the same time demand can also fluctuate extremely. The effects of the crisis as well as the implemented measures should therefore always be considered with regard to the entire company. In addition, crises can bring about rapid changes in situations and thus also in the requirements for SCRM, so that it may be necessary to shorten the update cycle in order to create risk transparency. In the best case, companies act on the basis of daily updated data, which underlines the advantages of digital tools. Due to the threat to the company's existence associated with the crisis, an assessment of the measures to be implemented in terms of their impact on the company's liquidity is imperative. In this case, scenario analyses are recommended as appropriate tools due to the uncertainty that often prevails. In addition, in order to maintain the company's liquidity, the company's demand and supply should always be considered in combination and reconciled. As a negative example, the classic reaction of many companies to uncertainties in the supply chain is to increase the range of coverage through buffer

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stocks, which can contribute to a significant deterioration of the company's liquidity situation in the event of a simultaneous slump in demand. This emphasizes the relevance of overall corporate action in the context of crises. However, the short-term changes in the situation in the context of crises also require companies to react quickly. In this case, the installation of a crisis team with the aim of accelerating decision-making can be expedient. In addition to rapid decision-making, the recognition of certain crisis effects and the implementation of specific measures can also influence the speed of the crisis process for the company. In the course of this, business continuity plans with pre-planned measures can bring about a higher speed. In addition to measures to mitigate the crises, strategies and measures to restore full performance should also be developed at the same time as part of ramp-up plans. These serve to plan the resumption of regular business activities after the crisis has been overcome. Observing the recommendations for action described above can enable companies to achieve greater resilience in the face of supply chain-induced crises, as the vulnerability of the supply chain is considered and analyzed as part of the preparatory measures in order to subsequently justify a continuous reduction in the risk level of the supply chain through individually developed measures. In the event of a crisis, companies are prepared in terms of their options for action, speed of action and information base through the described implementation of SCRM to the extent that they can develop their full entrepreneurial potential. The recommendations for action in the event of a crisis make decision-makers aware of the special aspects of a crisis and support the selection of measures or strategies by focusing on elementary crisis characteristics.

5 Conclusion and Outlook

Within the scope of the contribution, a concept for implementing SCRM in crisis situations was developed on the basis of recommendations for action. The insights gained from the analysis of existing approaches and the findings from the expert interviews were finally incorporated into the development of the concept. This includes general recommendations for action to implement an SCRM as well as specific measures to prepare for and manage crisis situations. The primary areas addressed are the

integration of SCRM into the organization, the systematic design of the SCRM process, the digitization of the area, and building resilience through more flexible structures and collaboration within the value network. In addition, explicit guidance on how to handle crises in the SCRM domain is presented. The paper explicitly places the needs and requirements of the practical application of SCRM in the foreground of the concept and presents elements of crisis management in the context of SCRM that build on each other.

Despite a carefully chosen approach and methodological fidelity, this paper is subject to limitations. For example, the results of the structured literature analysis are partly subject to a web search limited by search stop ($n = 50$), which is why a completeness of the obtained data cannot be guaranteed. Furthermore, the qualitative analysis of the existing approaches is subject to a subjective influence with regard to addressing the relevant disciplines

Due to the implementation of the small number of nine expert interviews, the interview study is only a section of the basic population and cannot claim to represent it completely. With regard to the analysis of the corona pandemic and the discussion of this crisis situation in the course of the expert interviews, it must be taken into account that at the time the interview study was conducted, the crisis had not been concluded and it was therefore not possible to take a fully comprehensive view. Furthermore, for the most part, industry-specific factors are not taken into account when considering the crisis example.

In the context of further research projects, other cases of the practical application of SCRM should be considered in order to explore the requirements of practice in even greater detail. This could provide further insights into the successful implementation of SCRM in general and also into the addressing of crises in this context. In addition, an industry-specific analysis may be useful to identify special aspects of the respective industry in the area of SCRM and to use these for the development of concrete recommendations for measures. The level of detail of such considerations can exceed that of the present work and thus make an important contribution to practical application. Furthermore, a consideration of crisis management in the field of SCRM during the corona pandemic with some distance after the pandemic seems to make sense, as this would allow a full consideration of the crisis period as well as the

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knowledge gained from research and practice. The present contribution already provides a considerable benefit in this regard, so that further work can build on it. Likewise, building on the findings of this work, the long-term changes in the practical application of SCRM should be considered on the basis of the events in the context of the corona pandemic.

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References

- Abele, E. and Reinhart, G., 2011. *Zukunft der Produktion: Herausforderungen, Forschungsfelder, Chancen*. München: Hanser.
- Adams, R. J., Smart, P. and Huff, A. S., 2017. Shades of Grey: Guidelines for Working with the Grey Literature in Systematic Reviews for Management and Organizational Studies. *International Journal of Management Reviews*, [e-journal] 19(4), pp. 432–454.
- Bundesverband Materialwirtschaft, Einkauf und Logistik in Österreich (BMÖ), STÖHR FAKTOR Unternehmensberatung GmbH and International School of Management (ISM), 2021. *Ein Jahr Covid-19 – Erfahrungswerte der Unternehmen und Entwicklungstrends in Einkauf und Supply Chain Management: Ergebnisse der Umfrage*. Wien/Erkrath/München. <<https://stoehrfaktor.de/dokumente/download-studien/2021-06-ein-jahr-covid-19.pdf>> [Accessed 7 May 2021].
- Chen, J., Sohal, A. S. and Prajogo, D. I., 2013. Supply chain operational risk mitigation: a collaborative approach. *International Journal of Production Research*, [e-journal] 51(7), pp. 2186–2199.
- Christopher, M., 2011. *Logistics & Supply Chain Management*. 4th ed. Harlow: Financial Times Prentice Hall.
- Christopher, M. and Lee, H., 2004. Mitigating Supply Chain Risk Through Improved Confidence. *International Journal of Physical Distribution & Logistics Management*, 34(5), pp. 388–396.
- Fiege, S., 2006. *Risikomanagement- und Überwachungssystem nach KonTraG: Prozess, Instrumente, Träger*. Zugl.: Berlin, Techn. Univ., Diss., 2005. [e-book]. Wiesbaden: Deutscher Universitäts-Verl.
- Fink, A., 2014. *Conducting research literature reviews: From the internet to paper*. Thousand Oaks California: Sage.
- Garousi, V., Felderer, M. and Mäntylä, M. V., 2019. Guidelines for including grey literature and conducting multivocal literature reviews in software engineering. *Information and Software Technology*, [e-journal] 106, pp. 101–121.

Supply Chain Risk Management in Crisis Situations

- Gläser, J. and Laudel, G., 2006. Experteninterviews und qualitative Inhaltsanalyse als Instrumente rekonstruierender Untersuchungen. 2nd ed. Wiesbaden: VS Verl. für Sozialwiss.
- Grewal, R. and Tansuhaj, P., 2001. Building Organizational Capabilities for Managing Economic Crisis: The Role of Market Orientation and Strategic Flexibility. *Journal of Marketing*, [e-journal] 65(2), pp. 67–80.
- INVERTO GmbH, 2020. Risiken systematisch identifizieren und reduzieren: Studienergebnisse und Handlungsempfehlungen von INVERTO. <<https://www.inverto.com/publikationen/risiken-im-einkauf-von-der-identifikation-bis-zur-steuerung>> [Accessed 26 May 2020].
- Jüttner, U., 2005. Supply chain risk management. *The International Journal of Logistics Management*, 16(1), pp. 120–141.
- Jüttner, U. and Maklan, S., 2011. Supply chain resilience in the global financial crisis: an empirical study. *Supply Chain Management: An International Journal*, 16(4), pp. 246–259.
- Jüttner, U., Peck, H. and Christopher, M., 2003. Supply chain risk management: outlining an agenda for future research. *International Journal of Logistics Research and Applications*, [e-journal] 6(4), pp. 197–210.
- Kajüter, P., 2003. Instrumente zum Risikomanagement in der Supply Chain. In: W. Stölzle, ed. 2003. *Supply Chain Controlling in Theorie und Praxis. Aktuelle Konzepte und Unternehmensbeispiele*. Wiesbaden: Gabler, pp. 107–135.
- Kersten, W., Held, T., Meyer, C. M. and Hohrath, P. A., 2007. Komplexitäts- und Risikomanagement als Methodenbausteine des Supply Chain Managements. In: I. Hausladen, ed. 2007. *Management am Puls der Zeit. Strategien, Konzepte und Methoden ; Festschrift für Horst Wildemann zum 65. Geburtstag*. München: TCW Transfer-Centrum, pp. 1159–1181.
- Kersten, W., Hohrath, P., Böger, M. and Singer, C., 2011. A Supply Chain Risk Management process. *Int. J. Logistics Systems and Management*, 8(2), pp. 152–166.

- Kersten, W., Schröder, M. and Indorf, M., 2017. Potenziale der Digitalisierung für das Supply Chain Risikomanagement: Eine empirische Analyse. In: M. Seiter, L. Grünert, and S. Berlin, eds. 2017. Betriebswirtschaftliche Aspekte von Industrie 4.0. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 47–74.
- Kersten, W., Schröder, M. and Nagi, A., 2022. Digitalisation - a challenging enabler for supply chain risk management. In: H. Corsten, and S. Roth, eds. 2022. Handbuch Digitalisierung. München: Franz Vahlen, pp. 743–758.
- Kleindorfer, P. R. and Saad, G. H., 2005. Managing Disruption Risks in Supply Chains. *Production and Operations Management*, 14(1), pp. 53–68.
- Krystek, U. and Lentz, M., 2014. Unternehmenskrisen: Beschreibung, Ursachen, Verlauf und Wirkungen überlebenskritischer Prozesse in Unternehmen. In: A. Thieß, ed. 2014. Handbuch Krisenmanagement. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 31–53.
- Krystek, U., Moldenhauer, R. and Angster, E. M., 2007. Handbuch Krisen- und Restrukturierungsmanagement: Generelle Konzepte, Spezialprobleme, Praxisberichte. Stuttgart: Kohlhammer.
- Li, G., Fan, H., Lee, P. K. and Cheng, T., 2015. Joint supply chain risk management: An agency and collaboration perspective. *International Journal of Production Economics*, [e-journal] 164, pp. 83–94.
- Manuj, I. and Mentzer, J. T., 2008a. GLOBAL SUPPLY CHAIN RISK MANAGEMENT. *Journal of Business Logistics*, 29(1), pp. 133–155.
- Manuj, I. and Mentzer, J. T., 2008b. Global supply chain risk management strategies. *International Journal of Physical Distribution & Logistics Management*, [e-journal] 38(3), pp. 192–223.
- Mayring, P., 2015. *Qualitative Inhaltsanalyse: Grundlagen und Techniken*. 12th ed. Weinheim: Beltz.
- Mayring, P., 2016. *Einführung in die qualitative Sozialforschung*. 6th ed. [e-book]. Weinheim, Grünwald: Beltz Verlagsgruppe; Preselect.media GmbH.

Supply Chain Risk Management in Crisis Situations

- Meuser, M. and Nagel, U., 2009. Das Experteninterview - konzeptionelle Grundlagen und methodische Anlage. In: S. Pickel, G. Pickel, H.-J. Lauth, and D. Jahn, eds. 2009. Methoden der vergleichenden Politik- und Sozialwissenschaft: Neue Entwicklungen und Anwendungen. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 465–479.
- Pearson, C. M. and Clair, J. A., 1998. Reframing Crisis Management. *Academy of Management Review*, 23(1), pp. 59–76.
- Pettit, T. J., Croxton, K. L. and Fiksel, J., 2019. The Evolution of Resilience in Supply Chain Management: A Retrospective on Ensuring Supply Chain Resilience. *Journal of Business Logistics*, [e-journal] 40(1), pp. 56–65.
- Radowski, H., 2007. *Netzwerkrisiken und Krisenmanagement in strategischen Unternehmensnetzwerken*. Wiesbaden: Deutscher Universitätsverlag.
- Rao, S. and Goldsby, T. J., 2009. Supply chain risks: a review and typology. *The International Journal of Logistics Management*, [e-journal] 20(1), pp. 97–123.
- Rosenthal, U., Charles, M. T. and 't Hart, P., 1989. *Coping with crises: The management of disasters, riots, and terrorism*. Springfield, Ill., U.S.A.: C.C. Thomas.
- Rosenthal, U. and Kouzmin, A., 1997. Crises and Crisis Management: Toward Comprehensive Government Decision Making. *Journal of Public Administration Research and Theory*, [e-journal] 7(2), pp. 277–304.
- Sodhi, M. S., Son, B.-G. and Tang, C. S., 2012. Researchers' Perspectives on Supply Chain Risk Management. *Production and Operations Management*, [e-journal] 21(1), pp. 1–13.
- Tang, C. S., 2006. Perspectives in supply chain risk management. *International Journal of Production Economics*, [e-journal] 103(2), pp. 451–488.
- Töpfer, A., 2006. *Werterhaltung und -steigerung durch Risiko- und Krisenmanagement*. In: N. Schweickart, and A. Töpfer, eds. 2006. *Wertorientiertes Management*. Berlin/Heidelberg: Springer-Verlag, pp. 377–407.