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A Bibliometric Analysis of Collaborative Supply Chain Risk Management in Crisis Situations

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Abstract

Crises including the COVID-19 pandemic have caused disruptive changes to many industries and supply chains around the world. Their severe impacts on business and the economy provide an opportunity to increase preparedness and reveal the importance of implementing a collaborative supply chain risk management process. This paper uses a bibliometric analysis based on a co-citation analysis to reveal the research areas and gaps concerning collaborative supply chain risk management with a focus on crisis situations. Using a structured approach based on Soni and Kodali [1] and Gmür [2], 269 papers were extracted from the database Web of Science (WOS) using a specific search string. Data filtering and preparation using title, abstract, and full paper screening, as well as the number of cited-in references, led to a final sum of 50 papers. These papers were prepared for the co-citation analysis based on a co-citation matrix that served as an input for the Organizational Risk Analyzer (ORA) software. The cluster analysis was carried out in the ORA software with a threshold of 0.01, and based on that, five clusters were extracted from the network. Extracted main research areas include collaboration approaches and criteria as well as decision-making approaches and lessons learned from COVID-19. Research gaps and suggested future research areas are presented based on the clusters analysis.

Keywords

Bibliometric analysis; Crisis; Corona; COVID-19; Co-citation analysis; Supply Chain; Risk Management

1. Introduction

Due to the close interconnectedness of companies, interruptions and disruptions in the supply chain not only affect the acutely affected organization but can also result in financial losses and reputational damage for other organizations in the value network (see [3,4]). In addition, globalization increases supply chain complexity and makes supply and demand more volatile and difficult to forecast. 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. 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 to establish appropriate risk mitigation strategies accordingly. These strategies should be accompanied by strong collaboration with supply chain partners to proactively manage different risk sources

Traditional supply chain risk management techniques rely on individual companies that define and implement mitigation measures for identified risks and their spillover effects. Therefore, collaborative

approaches provide an opportunity to increase the effectiveness of the supply chain risk management process by focusing on interfirm relationship arrangements [5].

Based on the current COVID-19 pandemic, a large body of literature focuses on publishing empirical and theoretical studies for topics related, for example, to supply chain resilience and crisis management. According to the knowledge of the authors, no previous studies focused on conducting a bibliometric analysis for collaborative supply chain risk management with a focus on crisis situations. For this reason, this paper aims at analysing the body of literature in this regard based on a co-citation analysis to examine the research areas and gaps. Building on this, suggested future research areas are presented to tackle existing and potential crisis situations. The paper proceeds in Section 2 by providing a brief theoretical background concerning supply chain risk management, collaborative supply chain risk management, and bibliometric analysis. Afterwards, the methodology of the bibliometric analysis is elucidated in Section 3. Section 4 presents the results of the cluster analysis as well as the research areas, gaps, and suggested future research recommendations. Finally, Section 5 presents the conclusion and an outlook for further research.

2. Background

2.1 Supply Chain Risk Management

For a company to be optimally prepared against the risks that may arise and to minimize possible damage, a risk management system should be put in place. Risk management also exists in the supply chain; however, it differs from classic risk management. Particularly within value chains that operate globally and dynamically, comprehensive risk management is of crucial relevance [6]. Supply chain risk management (SCRM) is a developing research area, stemming from the growing recognition of the value of supply chain risk by practitioners and researchers [7]. In our understanding, supply chain risk management (SCRM) is to be understood as "[...] *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.*" [8].

Proper assessment and planning using strategies, methods and tools for SCRM can minimize the impact of consequences that result from supply chain risks [9]. This necessitates a structured risk management process. The required steps comprise the identification, analysis, evaluation, and treatment of risks. Lastly, monitoring of risk management activities should be performed. These five steps of the risk management process should be carried out on a regular basis to meet the dynamic business environment [10].

Supply chain risk management is often linked with supply chain resilience. Supply chain resilience aims to maintain a certain desired performance in spite of disruptions. [11]. It is defined as "*the firm's capability to withstand, adapt, and recover from disruptions to meet customer demand, ensure target performance, and maintain operations in vulnerable environments*" [12]. Supply chain resilience implies not only the ability of a system to "bounce back" after a disrupting event but also the ability to adapt and transform [13].

2.2 Collaborative Supply Chain Risk Management

While coordination and collaboration are included in SCRM definitions, traditional SCRM approaches are not particularly effective in fostering inter-firm arrangements to deal with risk spillovers both within firms and across supply chains [5]. Collaboration among supply chain partners is the key mechanism for a good resilience against damage in case of any crisis [14] and can be categorized based on micro-, macro-and meso-levels [15].

The micro-level describes the direct coordination among organisations about supply risk prevention and recovery. The macro-level comes into place when organizations collaborate with other institutions such as the government, whereas the meso-level occurs when several supply networks work together on short- to

medium-term supply risks [15]. Prerequisites for good cross-organisational collaboration are trust between the different actors, full traceability of the supply chain, awareness, knowledge of SCRM and its processes, and sharing of knowledge and information [14,16].

In seeking logistics solutions, risk managers embrace an attitude of exchange and collaboration with partners regarding aspects related to risk mitigation and sharing [17]. Risk information sharing, supplier trust, and shared SCRM understanding can influence the effectiveness of collaboration among supply chain partners [18]. Companies reject isolated practices and individualistic or opportunistic behaviours such as transferring and managing risk in isolation [17].

3. Methodology

Bibliometric analysis is a comparatively novel approach towards making sense of available metadata from a vast number of sources derived from e.g., scientific databases or search engines. Its purpose is to uncover emerging trends, collaboration patterns or explore the intellectual structure of a specific domain [19]. The bibliometric analysis differs from a systematic literature review (SLR) in the fact, that an SLR tend to rely on qualitative techniques and is far better suited for confined research areas and that a bibliometric analysis solely relies on quantitative analysis that reduces researcher and author bias [19]. Bibliometric analysis can handle a large number of literature sources compared to SLRs, which typically contain a smaller number of papers for review. To investigate data, bibliometric methods such as citation analysis, co-citation analysis and bibliographic coupling are normally used [20].

The co-citation analysis provides an effective methodology to analyse the relationship among core aspects of a specific scientific domain [21]. When two documents are cited together in one or more published articles, they are considered to be co-cited [22]. Co-citation count determines the proximity of content between two published articles [2]. This allows the extraction of clusters that correspond to research areas within a specific scientific domain. The overall research design of the performed analysis is adapted and further developed from [1] incorporating the bibliometric analysis based on [2] as illustrated in Figure 1.

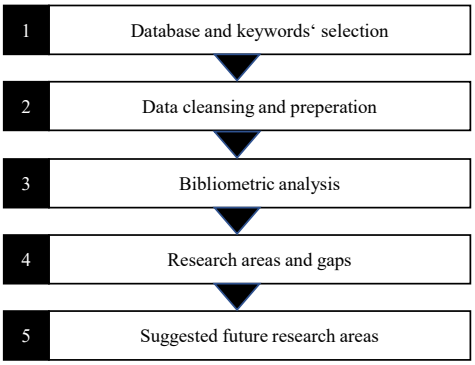

Figure 1: Approach of the research paper (own illustration based on [23])

First, Web of Science (WOS) was selected as a scientific database that includes required citation information. A specific set of keywords was selected as a search string to extract relevant articles from the database. This search string was entered in WOS using the logical operators “AND” and “OR” as follows:

- ("Cooperat*" OR "Co-operat*" OR "Collaborat*") AND "Risk manag*" AND "Crisis" (All Fields) **OR**
- ("Cooperat*" OR "Co-operat*" OR "Collaborat*") AND "Risk manag*" AND ("Corona" OR "Covid") (All Fields) **OR**
- ("Cooperat*" OR "Co-operat*" OR "Collaborat*") AND "supply chain" AND "Risk" AND ("Corona" OR "Covid") (All Fields)

Second, the data cleaning and preparation step mirrors the filtering procedure required to obtain a set of articles relevant to the area under study. Duplicates and articles with missing information were removed from the dataset, and the title and abstract of each article were then carefully read and reviewed to remove irrelevant articles. Afterwards, a full-text screening was conducted to extract the final set of articles for the descriptive and co-citation analysis.

Third, descriptive and co-citation analysis were conducted on the final set of articles, and the resulting findings were further examined in the fourth step to identify the main research areas and gaps in the current literature with regards to collaborative SCRM in crisis situations. Lastly, suggested future research areas based on the research gaps are proposed in the fifth step.

The adopted document co-citation approach in this study reflects the content proximity within a research discipline by analysing co-citations among selected peer-reviewed documents. Within the co-citation analysis, a specific method for calculating the co-citation frequencies is required as an input for the cluster analysis [2]. In this research, a Visual Basic for Applications (VBA) Macro code is developed in Microsoft (MS) Excel to calculate the co-citation frequencies. The cluster analysis is conducted using the Organisational Risk Analyser (ORA) software, a dynamic meta-network analysis and assessment tool developed by CASOS at Carnegie Mellon University in Pittsburgh, USA.

4. Results and Discussion

4.1 Descriptive analysis

The authors carefully selected 55 relevant articles from the 269 articles that emerged from the database queries based on the data cleaning and preparation phase. This phase comprises articles with missing information, title and abstract screening, as well as full-text screening. In total, 55 papers are considered to be relevant (see Figure 2).

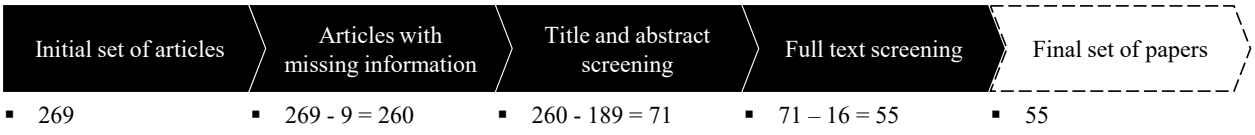

Figure 2: Data cleansing and preparation

In order to characterize this final dataset of relevant articles, descriptive figures are used. The descriptive analysis comprises the chronological development of the articles as well as the 10 most cited first authors.

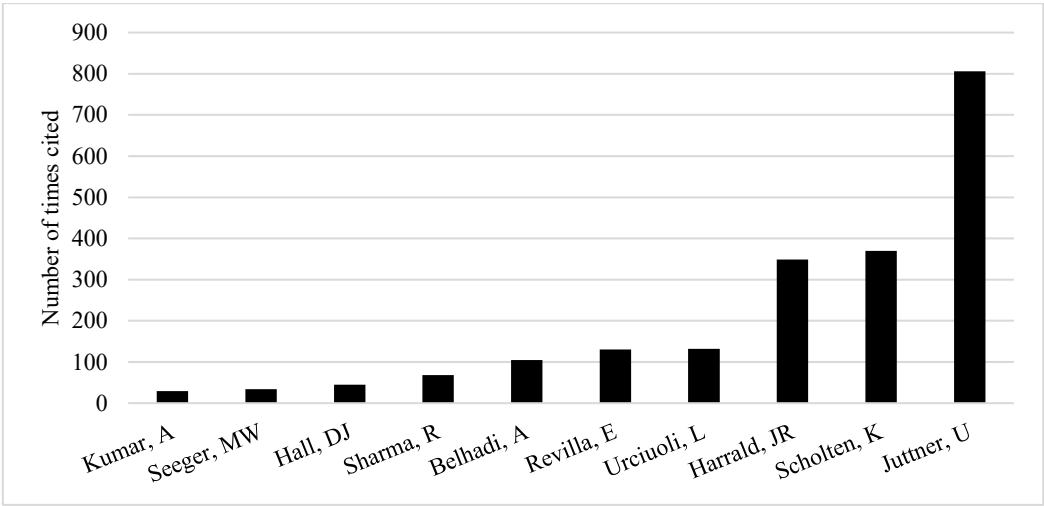

Figure 3: Most cited first authors

The most cited first author (Juttner, U), based on the extracted papers from WOS, focuses on supply chain resilience in the global financial crisis. Similarly, the author (Scholten, K) examined supply chain resilience and developed an integrated supply chain resilience framework. The third most cited first author (Harrald, JR) presented critical success factors in his paper to prepare and respond to extreme events. The other authors focus on different studies related for instance to risk mitigation strategies, resilience approaches, inter-organisational collaboration, as well as learnings from COVID-19.

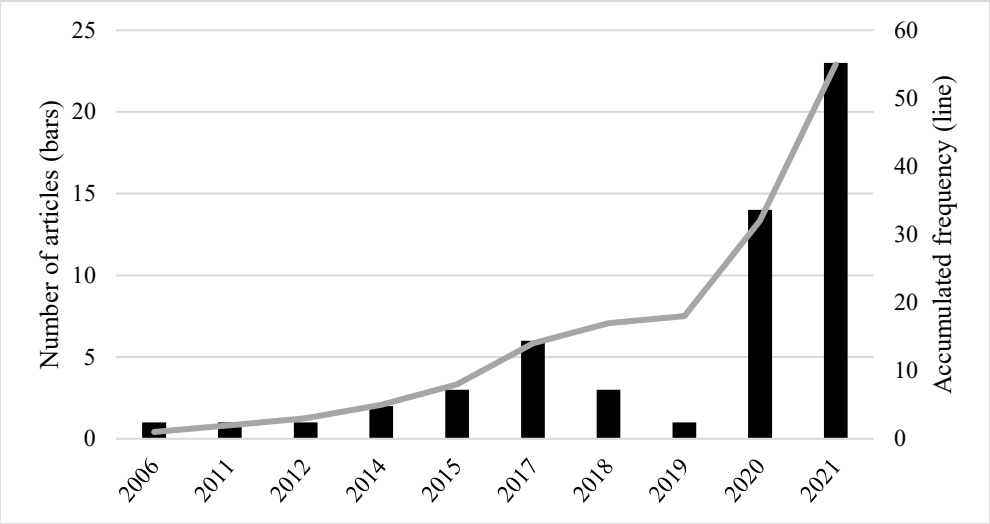

Figure 4: Number of papers per year

The chronological trend of the extracted papers is presented in Figure 4. An increase in the number of papers is observed in the years 2020 and 2021 due to the COVID-19 pandemic. Before that, the number of papers published for crises noticed a slight increase until 2017. There is a gap between 2006 and 2011 with no papers published that deal with collaboration in crisis situations. The cluster analysis of the final dataset is presented in the next subsection.

4.2 Cluster analysis

The results of the co-citation analysis are presented in this subsection based on the previously described steps (see Figure 5). All cited-in references for each article were stored separately in MS Excel worksheets that correspond to each article. Five papers from the dataset were not cited by any authors and therefore were excluded from the analysis. The cited-in references were downloaded using the library of Google Scholar and saved as CSV files for each article. In total, 2,455 cited-in references are distributed among the 50 articles.

For the calculation of the co-citation frequencies, a 50 x 50 raw co-citation matrix was programmed using VBA Macro in MS Excel. The co-citation matrix represents an integral input to the ORA software. Using a developed Macro, the raw co-citation matrix was generated by comparing the list of cited references for each article in each worksheet. By looping through each article, the Macro enters the frequency of co-citation in the appropriate field in the co-citation matrix.

The CoCit score was selected as the primary approach for creating the co-citation network and clusters. According to [24], the CoCit minimizes the relation of citation between the two co-citation partners. The approach adopts a value between 0 and 1 and associates the sum of co-citation counts with the mean and minimum values of the two individual citations.

The analysis was done in the ORA software with a threshold value of 0.01. This threshold value was adjusted manually until a clear pattern was detected. An additional revision of the articles' abstracts and introductions

was conducted to extract the clusters from the network. Of the 29 articles in the final data set filtered using the threshold value, 20 are clustered references in the co-citation network.

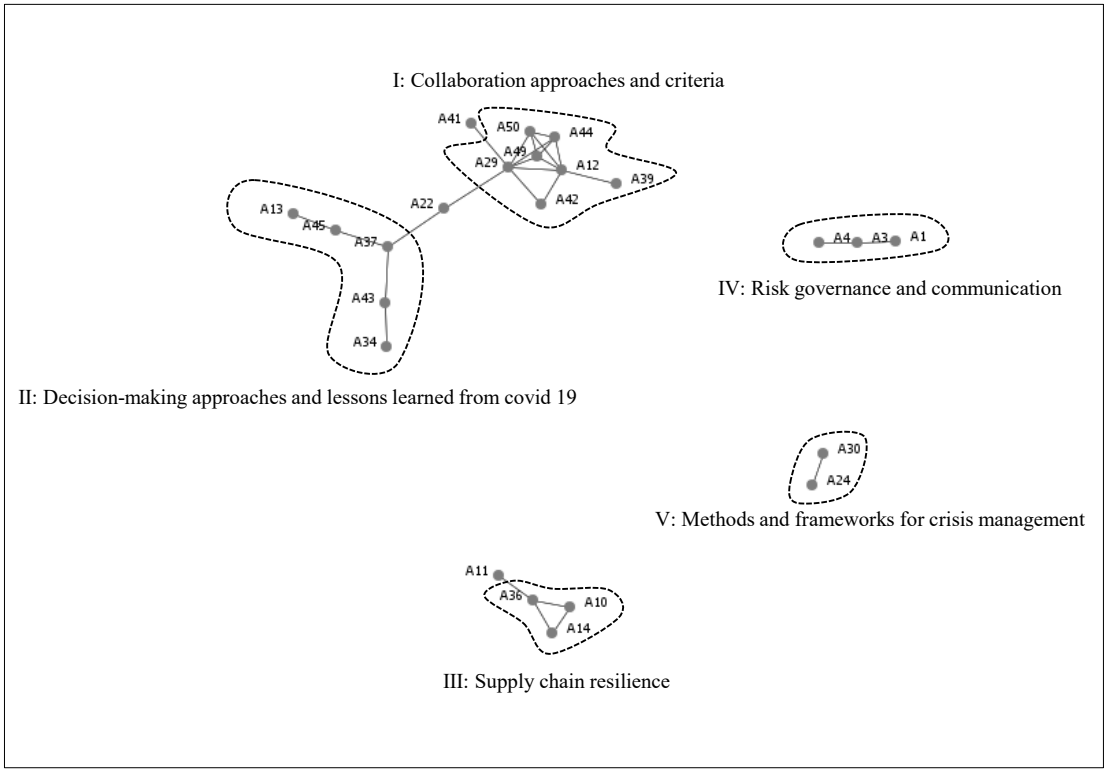

Figure 5: Clusters of the co-citation analysis

Cluster (I): Collaboration approaches and criteria (7 papers)

This cluster deals with collaborative approaches and criteria in different industries with a focus on the COVID-19 pandemic. Reference A42:[15] developed a typology of resiliency strategies concerning different collaboration types within and between supply networks. Reference A50:[25] analyse and discuss based on a literature review and case study research the relationships between fast-fashion retail chains and their suppliers' customers. The authors provided best business practices concerning cooperation with suppliers. Reference A12:[26] presents in their paper a collaborative approach for maintaining optimal inventory and mitigating stockout risks during a pandemic in healthcare supply chains based on a systematic literature review. Reference A39:[27] examine in their paper the role of relationship management between hotel chains and their key Tourism Supply Chain (TSC) agents to mitigate economic disruptions of epidemic outbreaks. Reference A49:[28] identified in their paper a total of 46 cross-sector collaboration activities based on the disaster management phases and resilience criteria that cover robustness, visibility, velocity and flexibility. Reference A29:[14] utilises seven semi-structured interviews with supply chain actors in the healthcare personal protective equipment supply chains as well as document analysis to analyse supply chain resilience during the COVID-19 pandemic response. The authors concluded that collaboration is considered a key to resilience. Reference A44:[29] found out in their paper that Collaboration Efficiency is the main criterion for accelerating the performance of Retail Supply Chains (RSCs) in a dynamic social environment. They concluded that RSCs require full integration and collaboration to mitigate the risks during and post-pandemic.

Cluster (II): Decision-making approaches and lessons learned from COVID-19 (5 papers)

This cluster deals with decision-making approaches for risk management and lessons learned from COVID-19. Reference A43:[30] present in their paper risk mitigation strategies for perishable food supply chains based on the fuzzy-best worst methodology (F-BWM). Reference A45:[31] focuses on the development of

a framework to utilise lean, agile, and leagile strategies in the supply chains. The authors analysed as well the impact of these strategies on crisis using the example of COVID-19. Reference A34:[32] examined agricultural supply chains risk caused by disruptions and identified strategies for decision-makers such as supply chain collaboration and shared responsibility. Reference A13:[16] stress the importance of involving communities in decisions during and after a crisis event occurs. The authors propose that risk managers may benefit from incorporating collaborative planning principles in their approaches, especially at the prevention stage. Using seven companies from different industries, supply chain positions, and countries, reference A37:[33] examine how insights from theories of the total cost of ownership, supplier segmentation, and supply chain change management can be applied to efforts to manage COVID-19 risks and disruptions in the supply chain.

Cluster (III): Supply Chain Resilience (3 papers)

This cluster comprises three papers that deal with supply chain resilience. Reference A10:[34] conceptualizes supply chain resilience and investigate its related concepts of SCRM and supply chain vulnerability. The authors of A36:[35] develop an integrated supply chain resilience framework utilising a qualitative case of a collaborative agency. Finally, reference A14:[36] analyses how energy supply chains function to increase resilience in the face of exogenous security threats and what support mechanisms the European Union should subsequently introduce or improve.

Cluster (IV): Risk governance and communication (3 papers)

This cluster deals with studies related to risk governance and communication with stakeholders. The authors of A4:[37] focus on defining the term supply chain governance and developed an associated conceptual framework that reflects different types of supply chains and actors. Reference A1:[38] deals with risk information sharing and investigates communication challenges linked to risk and vulnerability assessment. Similarly, reference A3:[39] focuses on communicating risk in disaster management systems, and based on two experiments, the authors reached a conclusion that the presence of risk information greatly influences the ability of stakeholders to carry out well-informed decisions.

Cluster (V): Methods and frameworks for crisis management (2 papers)

This small cluster consists of two papers that present methods and frameworks for crisis management. Reference A24:[40] developed a method that integrates Business Impact Assessment (BIA) and Risk and Vulnerability Assessment (RVA) for the public crisis management sector. Reference A30:[41] develops a multilevel framework to enhance organisational resilience for responding to crises. The authors argue that crisis management and organisational resilience are shaped mutually across different levels, from environmental, organisational, to individual.

4.3 Main Research areas and gaps

Three main research areas were extracted based on the frequency of articles in each research area from the co-citation network. The threshold to detect a main research area is set to be three articles. First, collaborative approaches and criteria for different industries are thoroughly analysed by different authors as can be observed in the first cluster. For instance, papers related to this area investigate collaborative approaches for inventory optimization and criteria such as collaboration efficiency. Second, there is a focus on resilience as well as supply chain resilience approaches and frameworks that were developed for crisis management which can be noticed particularly in the third and fifth clusters. Papers from these clusters utilized conceptual analysis, qualitative case study as well as empirical studies. Third, decision-making approaches and lessons learned from the COVID-19 pandemic (see cluster II) is a main research area that tackles supply chain risks caused by disruptions. The incorporation of communities and collaborative planning principles are examples of decision-making approaches from this cluster to manage supply chain risks caused by disruptions.

From the cluster analysis, only a few studies focused on the role of risk governance and risk communication in managing risks or crisis situations. Additionally, only a few papers developed methods and frameworks for crisis situations based on SCRM. There is a lack of papers that provides conceptual analysis and a roadmap for implementing collaborative SCRM with a focus on crisis situations. None of the papers as well considered the integration of business continuity management with collaborative SCRM. Based on the aforementioned research gaps, suggested future research areas are elaborated in the next subsection.

4.4 Suggested future research areas

There is a need to conduct further research concerning frameworks and models that can guide companies in understanding the requirements for implementing a collaborative SCRM process. Empirical studies based on interview and survey studies can examine the current status of collaborative SCRM and extract implementation aspects. There is also a need to analyse the impact of risk governance on collaborative SCRM. In this regard, case studies, as well as explorative approaches, are recommended to understand the current situation, challenges, and opportunities for collaborative risk management. Transdisciplinary studies integrating related research fields such as resilience and business continuity management are recommended to develop holistic frameworks and models that support collaboration aspects, especially in crisis situations. Studies that define maturity levels linked to Key Performance Indicators (KPI) for collaborative performance systems can help companies to understand and improve their current collaborative risk management level (see [5]). An operationalization process is required in advance to enable the proper assessment of collaboration in SCRM.

5. Conclusion and outlook

This paper utilised a bibliometric analysis based on a co-citation analysis to reveal the research areas and gaps concerning collaborative SCRM with a focus on crisis situations. Based on the analysis, three main research areas are extracted: (1) collaborative approaches and criteria for different industries such as healthcare and fashion (2) resilience and supply chain resilience approaches and frameworks for crisis management (3) decision-making approaches and lessons learned from the COVID-19 pandemic. Besides the research areas, the research gaps are extracted based on the cluster analysis. A gap was detected concerning methods and frameworks for crisis situations based on SCRM. Another deficiency is connected to studies that provide conceptual analysis and a roadmap for developing a collaborative SCRM with a focus on crisis situations. Lastly, a clear gap is noticed with regards to the integration of business continuity management with collaborative SCRM. Based on the research gaps, future research areas are suggested covering collaborative SCRM, business continuity management, resilience and risk governance encompassing theoretical, conceptual, and explorative approaches.

The co-citation analysis performed in this study has several limitations. First, the extracted papers were based on a specific search string that could have omitted other relevant papers. Second, several papers were not cited at all or only cited by a few authors since a large number of papers were published in the years 2020 and 2021. Third, the cluster analysis was based on the CoCit method for generating the co-citation network. Future studies should consider applying a Multi Vocal Literature Review (MLR) to systematically analyse both white and grey papers. The current research indicates a clear research gap concerning holistic frameworks and models for implementing collaborative SCRM. Therefore, it is recommended to develop theoretical and conceptual frameworks as well as models that present the building blocks and aspects for implementing a collaborative SCRM from theory and practice. These models and frameworks should investigate, for instance, the role of supply chain risk governance on collaborative SCRM as well as investigate how collaboration approaches for SCRM affect crisis management. Operationalization and quantification approaches that measure and assess the successful implementation of a collaborative SCRM and the intensity of collaboration should be examined in further research. The next step in our research is to

develop a conceptual framework for collaborative supply chain risk management with a focus on crisis situations.

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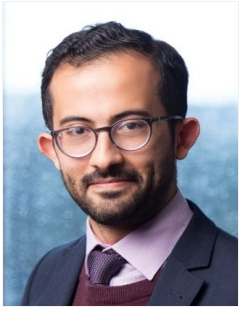
Biography



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