RIPPLE EFFECT IN SUPPLY CHAINS: A SYSTEMATIC LITERATURE REVIEW PROTOCOL

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ABSTRACT: Recently, supply chains had to cope with various exogenic disruptions. These disruptions are resulting in cascading failures that are spreading across all the supply networks, a phenomenon called the Ripple. Analyzing this phenomenon is the goal of this protocol. To do so, this paper aims to describe the structural steps of the protocol used to carry out an upcoming systematic literature review. Furthermore, the planned work on the way to the final literature review is defined. Therefore, research questions, for a qualitative argumentation with the ripple effect are phrased. The aim is to find out how resilient supply chain networks react on the ripple effect, how the effects of the exogenic shocks can be measured to compare supply chain networks, and which simulation techniques are appropriate to justify and quantify the results. Furthermore, the target quantitative bibliometric analyze patterns are defined and a brief conclusion is capturing achievments and stating out next steps.

Keywords: Supply chain management; Supply chain resilience; Supply chain risk management, Supply chain network, Ripple effect

1. PURPOSE OF THE PAPER

Supply chains need to cope with exogenic shocks like pandemics, environmental disasters, logistical interferences, and many more. All these shocks result in cascading failures spreading across entire supply chain networks (Hearnshaw & Wilson, 2013) (Zobel & Khansa, 2014). This phenomenon in logistical chains is called the "Ripple effect" (Sokolov, Ivanov, Pavlov, & Dolgui, 2015) (Bellamy & Basole, 2013).

Against the background of the growing importance of global value chains and their increasing complexity, there is a consequently increasing susceptibility to errors in the processes of these chains. The COVID-19 pandemic, that caused immense disruptions in global supply chains, is on extreme example how an exogenic shock can negatively influence supply chains. Global shortages in construction material, computer chips and other goods caused by capacity restrictions enforced by the pandemic can be seen all over the world. Virtually every globally acting company is facing the challenges of returning to former competitiveness after a supply chain disruption. Consequently, building a resilient supply chain in the post-pandemic world will be one of the main tasks for leading decision makers in globally operating companies (Shih, 2020).

Constantly developing management approaches and combining them with research around the systematic network setups can, therefore, help to temper ripple effects. However, research on ripple effects in the context of management practices and approaches seems to be a potential white research spot to cover. Addressing this gap, the upcoming systematic literature review, based on this protocol, has been initiated. The aim of this literature review is to continue the idea of the paper "Ripple effect and supply chain disruption management: new trends and research directions" were Alexandre Dolgui & Dmitry Ivanov are proclaiming that future research in dynamic analysis of the supply chain ripple effect (simulations & control theory), and the network structures with their influence on coping with the ripple effect, is necessary (Ivanov & Dolgui, 2021). Grounding on that ideas the following research questions will be investigated:

- In order to compare supply chain network designs against each other - what interdisciplinary set of key performance indicators can be used to characterize supply chain networks?
- Which supply chain network design is helping supply chains to be resilient against exogenic shocks?
- Furthermore, is there a difference in performance losses of supply chain networks in order to where the exogenic shock is hitting a supply chain network (Upstream/Downstream)?
- Simulation techniques can be mainly split into two groups, Continuous simulation, and Discrete-event simulation (Fishman, 1978). Which simulation approaches are the most suitable for modeling the ripple effect of global supply chains?

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2   METHODOLOGY

2.1   *Expected steps in a literature review*

According to the PRISMA procedure, a literature review is split into 4 phases (Moher, Liberati, Tetzlaff, & Altman, 2009). Currently this research project is in the phase of identification. That means research approaches, search strategies, and research results for the first PRISMA phase will be descripted and justified in the following paragraph. An outlook of the upcoming research activities in the screening - and eligibility phase will be given in the methodology section, and the planned analysis done on the identified record set will be described.
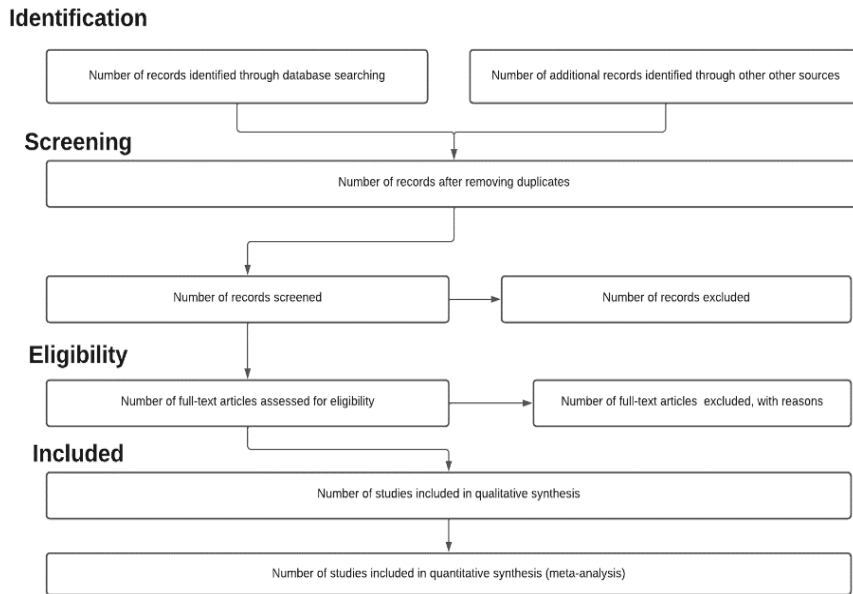
Identification

Number of records identified through database searching

Number of additional records identified through other other sources

Screening

Number of records after removing duplicates

Number of records screened

Number of records excluded

Eligibility

Number of full-text articles assessed for eligibility

Number of full-text articles excluded, with reasons

Included

Number of studies included in qualitative synthesis

Number of studies included in quantitative synthesis (meta-analysis)

Figure 1. Flow of information through the different phases of a systematic review (Moher, Liberati, Tetzlaff, & Altman, 2009)

Bibliometric analyses are gaining great popularity in research though the last years (Donthu, Satish, Debmalya, & Weng, 2021). To give guidance for bibliometric analysis, the "Prisma-Statement", published in 2009, describes a four-step methodology to execute bibliometric analysis. Figure 1 shows this process. The phases described are the identification-, screening -, eligibility- and inclusion phase. Within the first phase, the relevant records are identified. Therefore, the results of the publications identified within a scientific database and other sources are combined.

A predefined search strategy, containing inclusion and exclusion criteria, is used to determine the boundary conditions of the identification phase. As a bibliometric analysis is usually done utilizing several research databases, the set of identified records might contain duplicates. These are removed in the screening phase. Within the eligibility phase, the identified and screened records are checked for their full text availability. All records that passed the screening and eligibility phase will build the basement for qualitative and quantitative synthesis (Donthu, Satish, Debmalya, & Weng, 2021) (Moher, Liberati, Tetzlaff, & Altman, 2009).

For the quantitative synthesis the technique of bibliometric analysis, a method to retrospect and descript publishes papers, is used (Ding, 2019). With the aid of this technique selected research areas are assessed (Small, 1973). Sophisticated bibliometric studies can build a solid foundation for advancing a research field in significant ways by enabling and empowering scholars to gain an overview over a research area, helping to identify knowledge gaps and research ideas, and positioning their intended contributions to the field (Donthu, Satish, Debmalya, & Weng, 2021). Bibliometric analyses are, thereby, analyzing secondary data acquired on research databases from a quantitative perspective (Albort-Morant & Domingo, 2016). Therefore, the results of such analysis can be characterized as systematically, transparent, and reproduceable. Thereby, they are enhancing the reliability and the quantity of the literature review (Bellis, 2012).

The techniques for bibliometric analysis can be split in the categories performance analysis and science mapping (Donthu, Satish, Debmalya, & Weng, 2021). Performance analysis focusses on the contribution of research groups to a given field (Cobo, Lopez-Herrera, & E., 2011). The descriptive analysis is a standard practice for reviewing and presenting the performance of different research constitutes (e.g., authors, institutions, countries, and journals) in a certain research field. There are a lot of acknowledged measures that are used in performance analysis. The most prominent measures are the number of citations or publications per year or per research constituent (Donthu, Reinartz, Kumar, & Pattnaik, 2020) (Donthu, Satish, Debmalya, & Weng, 2021). Not all of them are individually named here. For an holistic overview and possible metrics of performance analysis, see article "How to conduct a bibliometric analysis: An overview and guidelines" from Naveen Donthu and colleagues gives an good overview about the metrics for performance analysis. (Donthu, Satish, Debmalya, & Weng, 2021)

In contradistinction to the performance analysis, the technique of science mapping is investigating the relationship between certain research constituents (Baker, Kumar, & Pandey, Forty years of the Journal of Futures Markets: A bibliometric overview, 2021) (Rodrigues & Navarro, 2004) by analyzing the intellectual interaction and structural connection between research constitutes. Some famous representatives for science mapping are the citation analysis or bibliographic coupling (Baker, Pandey, Kumar, &

Haldar, 2020). Further techniques are highlighted in the article "How to conduct a bibliometric analysis: An overview and guidelines" from Naveen Donthu and colleagues. (Donthu, Satish, Debmalya, & Weng, 2021)

Besides the quantitative synthesis, the identified record out of the PRISMA flow will be analyzed in a qualitative way. Therefore, the included record sets will be read and interpreted with the goal of answering the detained research questions.

2.2 *Progress, context, strategies and expected results*

A protocol describes how a research question will be answered, in such a way that it allows to obtain a global vision of every aspect related to the research to be conducted. The main objective of a research protocol is to guide investigators and other parties through the elements that should be considered during the planned study (Silverman & Kwiatkowski, 1998). Picking up the definition of the work that should be done in a research protocol, the aim of the following paragraph is to reflect the steps that will be proceeded during the planned literature review. Furthermore, the section aims to reflect the actual status of the research activities.

a) Search Strategy for the identification phase

The search strategy for the identification phase needs to reflect the goals and objectives of the overall research plan. The research question that should be answered with that literature review are narrowing down the professional scope of the search strategy. Nevertheless, supply chain management is an interdisciplinary management area that is covering many individual disciplines (New & Payne, 1995). Considering the right research databases to use, Scopus and Web of Science (WOS), which represent research area overreaching platforms, seems to be most suitable.

Following the idea of Ivanov stating that the ripple effect and the research around that issue is a quite new and unexplored research area, it seems obvious to not chronically restrict the search scope in advance (Ivanov & Dolgui, 2021). Furthermore, an interesting question to answer is the first appearance of the ripple effect in the research area of supply chain management. Consequently, there is no time limitation set up in the research strategy.

Moreover, a worldwide search perspective is important to analyze the geographic distribution of the resulting record set. A science map will be used to find out which are the most influential or active regions in that research perspective. English as the global leading language should be a key criterion for the search strategy. Furthermore, due to the authors' personal backgrounds, publications written in German are also included.

During the execution of shaping the search strategy, reflecting the goals and objectives in the inclusion criteria emphasizes that the ripple effect is a phrase used in many research disciplines. For example, it is described as a model for software maintenance as well as an effect impacting the global housing prices (I-Chun, 2018).

By limiting the search phrases, almost all irrelevant research areas where excluded. Only a variety of publications addressing software maintenance and development approaches remained. To avoid diluting the result record set with these results, the research area computer science was excluded from the search strategy. Details are shown in the table below.

Table 1. Inclusion and exclusion criteria of the search strategy

Index	Inclusion criteria - description
1	Journal, books, book chapters and articles indexed on the database of SCOPUS and Web of Science (WOS).
2	Published in any year (including in press).
3	They research the ripple effect in supply chain networks worldwide.
4	Written in English or German.
Index	Exclusion criteria - description
1	Articles, book chapters, congress articles or any source that has not passed a sophisticated review process.
2	Publications referring to a ripple effect that is not related to supply chain management, business logistics management and supply chain networks.
3	Research that has no clear relevance for the further research on the ripple effect in supply chain networks.
4	Papers with a straight technological focus.

The inclusion and exclusion criteria are building the framework to tailor down the search strategy to the predefined goals of the upcoming literature review. Taking these criteria and the reflection of the initial search activities into consideration, search terms were established. Depending on the used database, a different syntax for the search term is used and, therefore, the search terms slightly differ in their composition. But the expression of the search phrase is the same.

For the identification of the relevant record sets, a search phrase based on the topic is used. This means the title, the abstract, and keywords of the records on the database will be checked against the relevant search term. The search terms are thereby built up in three different search statements that are connected via the logical operand AND. This means that a relevant result record will use the connected search words in title, abstract and keywords. The via AND connected blocks are containing individual search phrases connected by the logical operand OR. This means a relevant record needs to contain at least one of the search words in a block.

Taking a closer look into the first search block shows the combination of the search terms "supply chain management" and "supply chain resilience". These phrases are limiting the scope of the relevant record set to the main relevant research area. The second search block is containing the search terms "supply chain networks" and "supply networks". Explicitly pointing out that resulting documents should contain information around network structures is a key element to fulfill the goals of the upcoming literature review and the predefined exclusion criteria. The third search block is characterized by the search terms "ripple effect", "cascading failure*", "contagion" and "disruption*". Ripple effect, cascading failure and contagion are similar used words in the research area supply chain management (Young Woong, Blackhurst, Chinju, & Scheibe, 2021). To prevent that the result is negatively influenced by a missing synonym all of them were used in the search term. The word "disruption*" is basically also describing an exogenic shock that can impact supply chains. Therefore, it is taken into consideration. To prevent a limited research quantity by not naming the plural of disruption in the search term, an asterisk /* was used. The final search terms are shown in the table below.

Table 2. Search terms for WOS and Scopus

Database	Quantitative Results	Search term:
Web of Science	82	(TS=("supply chain management" OR "supply chain resilience")) AND TS=("supply chain network" OR "supply network") AND TS =("ripple effect" OR "cascading failure*" OR contagion OR disruption*)
		Additional exclusion criteria: All papers of the research area "computer science"
Scopus	141	TITLE-ABS-KEY (("supply chain management" OR "supply chain resilience") AND ("supply chain network" OR "supply network") AND ("ripple effect" OR "cascading failure*" OR "contagion" OR disruption*)) AND (EXCLUDE (SUBJAREA , "COMP"))

The PRISMA flow diagram below gives an overview of the status of the literature review. Recently the identification phase was completed. Therefore, this is the only phase with available results. For all the other phases the estimated results and planned tasks will be described. While the database search in WOS revealed 82 relevant records, Scopus indicated 141 relevant records.
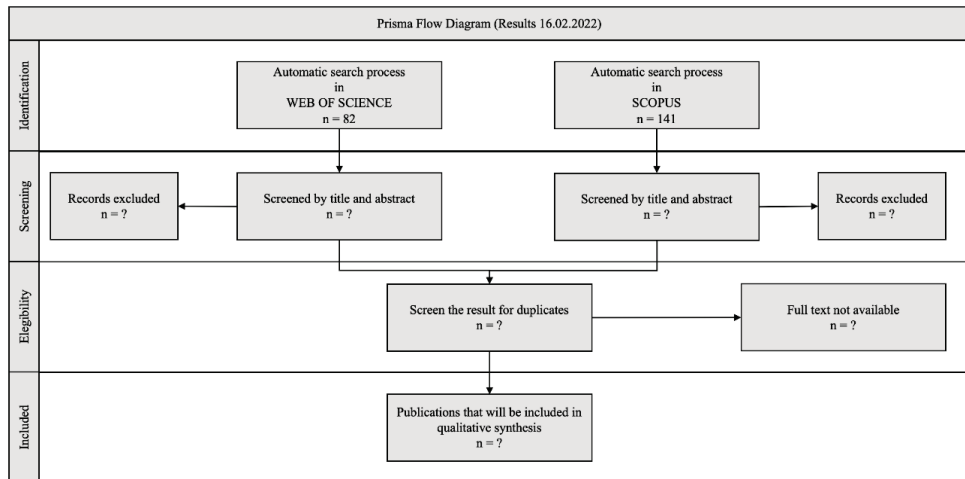
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Fig. 2. PRISMA diagram showing the results of the identification phase

b) *Screening strategy for the screening phase*

After the identification phase, it cannot be ruled out that there are irrelevant data records embedded in the identified record set. Therefore, the identified records will be sorted by descending publication date, title, and keywords. Moreover, the abstract of every relevant record set will be screened and compared manually against the research objectives. Duplicates are manually removed. The results of the manual screening process will be clustered. Cluster one will gather all the accepted (A) articles. Keywords, title, and abstract are clearly related to the research objectives. This record sets will pass the screening phase. Excluded publications (E) are mismatching the research objectives because of absenting matches in title, abstract and keywords. The records are excluded. There might be some articles where a comparison of title, abstract and keywords against the research objectives is sufficient to include or exclude one article. These records will be clustered for revision (R) and full text analysis will be done to decide if the article will be included or exclude. Table 3 highlights this process of the screening phase (Martinez-Tomas & Marin-Garcia, 2019).

Table 3. Selection codes and screening approach for the screening phase (Marin-Garciaa, Vidal-Carrerasb, & Martinezd, 2019)

Code	Definition	When used	Action
A: Approved	Title, abstract and keywords are clearly related to the objectives of the research.	When the item meets criteria of inclusion.	Include the item in the reference list. tagging as revision (R) or item (A)

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E: Excluded	The title, abstract and keywords are not related to the objectives of the study.	When the article meets the exclusion criteria.	Exclude the reference. Tagging as item (E).
R: Questionable	The article and abstract are not clearly related to the objectives of the study.	When there is no clear evidence that the summary is in accordance with the inclusion criteria but appears to be related to them.	Analyze the full text to determine whether this reference should be included in the study. Tagging it as item (A) or item (E).

c) Screening strategy for the eligibility phase

Articles that passed the screening matched the defined research objectives. During the eligibility phase the availability of the full text of the publication will be guaranteed. Therefore, the records classified as accepted will be checked for full text availability in WOS and Scopus.

d) Planned analytics based on the included publications

All articles that pass the eligibility phase will be taken into consideration for the bibliometric analysis. Therefore, different techniques and programs will be used to interpret the results of the upcoming literature review. Beside Microsoft Excel for performance analysis, VOSviewer (https://www.vosviewer.com/) will be used to perform scientific mapping. Both will be used to illustrate the results of the automatic literature search process. The following list shows the planned analytical approaches, divided by techniques for performance analysis and scientific mapping.

Table 4. Analytical techniques that are planned to use

Used technique for performance analysis	
	Descriptive statistics
	Chronological distribution of publications
	Most cited publications
	Most important authors
	Most impacted journals
	Most influential institutions
	Most outstanding countries
	Origin of authors
Scientific maps	
	Map of cited references
	Co-citation of cited references

	Map of the most cited authors
	Map of the most cited journals

3   CONCLUSION AND PLANNED NEXT STEPS

The objective of this protocol structure the future work done in the upcoming literature review. Therefore, the PRISMA methodology is introduced. Using this framework, the actual status of research is exposed and planned next steps are defined. The initial screening of the spawned results of the database query allows the conclusion that more research strands and areas should be reflected. The research area around simulation approaches to define the right strategic approach for the used simulation technique is not reflected adequately. Furthermore, the research strands around disaster theories or strategic risk management might be good candidates for extending the research query. These ideas are characterizing the planned next steps. Iterating and adapting the search terms so that they better reflect the research question will the main tasks for the next research phase. After that the results of the database search will be processed like explained with the PRISMA scheme. The final number of record sets will be quantitatively and qualitatively, with respect to the described research questions, analyzed and interpreted.

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