LUT School of Business and Management

Bachelor's thesis, Business Administration

Supply Management

Bibliometric analysis and systematic literature review of supply chain disruptions and the effect on performance

Toimitusketjun häiriöiden vaikutus suorituskykyyn, bibliometrinen ja systemaattinen kirjallisuus katsaus vuosilta 2011–2020

7.1.2022

Author: Eveliina Toivakka

Supervisor: Iryna Maliatsina

ABSTRACT

Author:	Eveliina Toivakka
Title:	Bibliometric analysis and systematic literature review of supply chain disruptions and the effect on performance
School:	School of Business and Management
Degree programme:	Business Administration, Supply Management
Supervisor:	Iryna Maliatsina
Keywords:	supply chain management, supply chain performance, disruption impact, systematic literature review, risks

In the current environment, understanding the impact of disruptions is becoming even more important than before. The purpose of this paper is to study the performance impact of disruptions in the context of supply chain management. Because the research literature covering the performance impact of disruptions is scarce, a systematic literature review was conducted.

Through the systematic literature review process, suitable articles were found, resulting in 62 individual articles. After forming the sample, the data was analysed with descriptive statistics and content analysis. The base of the content analysis was formed by clustering the author's keywords. Clustering of keywords was done with VosViewer. Based on the keyword map, the articles were divided into clusters and content analysis was performed based on them.

The main research question was not answered directly. Even though the articles assessed the performance impact of disruptions, they mainly contained only theoretical models. However, some important insights were found such as the importance of supply chain design and the role of information management. The research area would benefit from data based on objective measurements such as financial performance. Most of the articles were models and it would be important to test them empirically.

TIIVISTELMÄ

Tekijä:	Eveliina Toivakka
Tutkielman nimi:	Toimitusketjun häiriöiden vaikutus suorituskykyyn, bibliometrinen ja systemaattinen kirjallisuus katsaus vuosilta 2011–2020
Akateeminen yksikkö:	LUT-kauppakorkeakoulu
Koulutusohjelma:	Kauppatieteet, Hankintojen johtaminen
Ohjaaja:	Iryna Maliatsina
Hakusanat:	toimitusketjun hallinta, toimitusketjun suorituskyky, toimitusketjun häiriöt, systemaattinen kirjallisuuskatsaus, riskit

Nykytilanteessa toimitusketjun häiriöiden vaikutusten ymmärtäminen on entistäkin tärkeämpää. Tämän kandidaatintutkielman tarkoituksena on tutkia toimitusketjujen häiriöiden vaikutusta yritysten suorituskykyyn. Ilmiötä tutkiva tutkimuskirjallisuus on hajanaista, joten systemaattisen kirjallisuuskatsauksen suorittaminen on perusteltua.

Systemaattisessa kirjallisuuskatsauksessa löydettiin 62 sopivaa artikkelia. Otoksen muodostamisen jälkeen aineistoa analysoitiin kuvailevalla tilastoanalyysillä ja sisällönanalyysillä. Kirjoittajien valitsemien avainsanojen perusteella tehtiin ryhmittely, joka toimi sisällönanalyysin pohjana. Avainsanojen ryhmittely tehtiin käyttämällä VosViewer-ohjelmaa. Avainsanojen verkostokartan perusteella artikkelit jaettiin erilaisiin klustereihin ja niiden perusteella tehtiin sisällönanalyysi.

Suoraa vastausta päätutkimuskysymykseen ei löydetty. Vaikka artikkelit arvioivat häiriöiden vaikutusta suorituskykyyn, ne sisälsivät pääasiassa vain teoreettisia malleja. Sisällönanalyysin pohjalta voitiin tehdä kuitenkin johtopäätöksiä, kuten esimerkiksi toimitusketjun suunnittelun merkitys ja informaation hallinnan korostunut rooli. Tulevaisuudessa aihetta tulisi tutkia enemmän objektiivisiin mittareihin perustuen, esimerkiksi mitaten toimitusketjun häiriöiden taloudellisia vaikutuksia. Suurin osa artikkeleista oli malleja, joita olisi tärkeää testata empiirisesti.

TABLE OF CONTENTS

Appendices

List of figures

List of tables

1. INTRODUCTION

Bode and Wagner (2015, p. 216) define supply chain disruption as "… *the combination of an unintended and unexpected triggering event that occurs somewhere in the upstream supply chain (the supply network), the inbound logistics network, or the purchasing (sourcing) environment, and a consequential situation which presents a serious threat to the normal course of business operations of the focal firm.*" These events could emerge from natural disasters, internal factors such as product quality failure, or external factors such as demand spike (Macdonald & Corsi, 2013). For example, the volcano eruption in Iceland paralyzed Europe's air traffic and resulted in over 102 000 cancelled flights (Tieteen Kuvalehti, 2018). Disruptions can lead to major financial costs and long recovery times (Macdonald & Corsi, 2013).

The latest disruptive event has been the global pandemic that interrupted the whole world. Even though the global pandemic is still present, big companies such as IKEA (2021) still have trouble with the supply. The effect of disruptions to the performance can be divided into two categories which are financial and service impacts (Macdonald & Corsi, 2013). However, there are multiple different ways to measure it from the performance point of view. One of the performance measures is recovery speed (Macdonald & Corsi, 2013).

The area of supply chain disruptions has been extensively studied before with systematic literature reviews (Pournader, Kach & Talluri, 2020; Fagundes, Teles, Vieira de Melo & Freires, 2020; Colicchia & Strozzi, 2012). Pournader et al. (2020), Fagundes et al. (2020), and Colicchia and Strozzi (2012) focused their review on supply chain risk management. Although performance outcomes could be a good indicator of how well the disruption is handled, to achieve a greater understanding of the topic, there is a need to structure the separated pieces of research knowledge through a systematic literature review. Therefore, the aim of the present study is to fill the gap by conducting a systematic literature review on how supply chain disruptions affect companies' performance.

The paper starts with presenting the research problem and some definitions. The two applied approaches are presented next: systematic literature review and bibliometrics. The methodology used in this study is presented in the third chapter. The fourth chapter includes the descriptive statistics and content analysis of formed clusters. The fifth section presents the discussion and conclusions.

1.1 Research problem

The research questions and methods are presented in Table 1. This study aims to discover how supply chain disruptions affect companies' performance. Results might also reveal some other factors that might be taken into consideration when looking at disruption impact on companies. A systematic literature review ensures that the phenomenon can be viewed from many different perspectives and allows many sections to be filled. Without limiting the chosen research problem and topic too much, one can find out how the performance impact of disruptions has been studied. In addition, the study also looks at how the field of research has evolved. Sub-questions are more focused on the descriptive statistics of the studied topic and cover information about who is studying the area.

Table 1. Research questions and research methods.

Research question	**Research method**
Main research question	
How do supply chain disruptions affect companies' performance?	Content analysis
Sub-questions:	
How has the research on the topic changed over time?	Descriptive statistics
What are the top journals and articles in the sample by citation count?	Descriptive statistics
Who are the main researchers in the area?	Descriptive statistics
What kind of keywords are used in the sample?	Descriptive statistics/Co-word map visualization by VosViewer
What are the research clusters in the field?	Descriptive statistics/Co-word map visualization by VosViewer

1.2 Definitions

Larson and Rogers (p. 1998, 2) define supply chain management as "*the coordination of activities within and between vertically linked firms, for the purpose of serving end customers at a profit.*" Basically, it involves activities related to suppliers and delivering the end product to the customers. Risk management can be involved in supply chain management. Supply chain risk management is defined by Fan and Stevenson (2018, p. 210) following way: "*The identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques and strategies and of external coordination and collaboration with supply chain members so as to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage.*"

Tang (2006) divides supply chain risks into two different categories. The first category is operational risks which are related to the uncertainties in the business. These are for example cost changes, demand, or supply fluctuations. The second category is disruption risks. These are any sudden events that will disturb the supply chain such as earthquakes or economic crises. (Tang, 2006)

Kleindorfer and Saad (2005) presented the idea of disruption risk management, and they claimed that the first step in the management is the source recognition of vulnerabilities and risks. They list operational uncertainty, natural hazards, terrorism, and political instability as possible disruption sources. Operational uncertainty might arise from inside the company such as machine breakage or from external reasons which might be the loss of the main supplier, bankruptcy, and workforce-related issues. Political instability issues might arise when the government decides to change the law. (Kleindorfer & Saad, 2005)

Disruption can affect one node of the supply chain, but the impact might propagate into the network. This effect is called the ripple effect. The ripple effect can be prevented or mitigated through some actions. Reasons behind the ripple effect include for example low safety stock or single sourcing. The ripple effect can be controlled with proactive or reactive actions. (Dolgui, Ivanov & Sokolov, 2018)

The structure of the supply chain is the form of a supply chain, for example, the number of factories in it. Supply chain design could be seen as defining factor of the supply chain structure. The design focuses on for example choosing locations for factories to fulfil certain objects (Wang, Huang & Dismukes, 2005). These objects could be for example minimizing costs (Bottani & Montanari, 2010) or resilience (Ivanov, 2018) of the supply chain network.

Supply chain resilience could be seen as ability to recover from disruptions (Carvalho, Barroso, Machado, Azevedo & Cruz-Machado, 2012). It can also be seen as resistance against disruptions. It can be measured as decreased probability of disruptions or the consequences of the disruption (Ribeiro & Barbosa-Povoa, 2018). Resilient supply chains could be achieved by applying different strategies to improve resiliency. This could be for example inventory buffer or decreasing lead time (Barroso et al., 2010).

Supply chain performance measuring is possible in multiple ways. The first problem related to measuring the effect is if the measurement is about a single supply chain or overall performance. The performance of supply chains can be measured regarding a single product or product line. (Li, Fan, Lee & Cheng, 2015; Beamon, 1999) There are various possibilities of how supply chain performance might be measured. Beamon (1999) divided performance measurement into three categories. The first category is based on resources. This measurement includes analyzing inventory levels, workforce requirements, usage of energy, needs for equipment, and costs. The resource usage is mainly about efficiency and resource minimalization. It can be measured by related costs such as manufacturing cost or total cost and return on investment (ROI). The second measurement category is output-related. It can be measured for example in products produced, number of deliveries, customer satisfaction, and quality of production. This can be measured for example by sales, profit, stockouts, and fill rates. The last category is about flexibility. It might result in reductions in lost sales, late orders, and the ability to respond more quickly to any sudden event. (Beamon, 1999)

2. BIBLIOMETRICS AND SYSTEMATIC LITERATURE REVIEW APPROACH

A systematic literature review is a method for conducting a literature review. It follows specific steps that can help with conducting a literature review. Using bibliometrics with a systematic literature review helps to obtain more information about the studied area. Using both approaches is beneficial for the quality of the literature review. (Pulsiri & Vatananan-Thesenvitz, 2018)

This section discusses two complimentary approaches for conducting a research paper. The first section is about systematic literature review in general and its steps involved. The second section defines bibliometrics and its most common methods. Some programs are presented that can be used to support the analyses. Both sections cover the benefits and disadvantages of the methods.

2.1 Systematic literature review as a research method

There are differences between systematic and traditional literature reviews. The main difference is that unlike in traditional literature review, a systematic literature review starts by formulating a review protocol and the research problems. It also contains a search strategy with exclusion and inclusion criterium. The research process is portrayed in the work and anyone who can conduct it can have the same results. (Kitchenham, 2004)

Literature reviews can be divided into three main orientations. The first one is a descriptive literature review that is sometimes called a traditional literature review. It is the least restricted method of them all and can be divided further into two distinct orientations such as narrative and integrated methods. The second main direction is a systematic literature review. (Salminen, 2011) The systematic literature review will be discussed more in this section. The third one is a meta-analysis which can be divided into qualitative or quantitative research methods (Salminen, 2011).

The systematic literature review aims to answer specific research questions. Kitchenham (2004, p. 1) has defined it as *"A systematic literature review is a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest."* Systematic reviews can be used to understand phenomena, identify gaps in the current research and provide a framework for new research (Keele, 2007).

The distinction between the narrative and systematic review is discussed by Tranfield et al., 2003, p. 209) "*Systematic reviews differ from traditional narrative reviews by adopting a replicable, scientific and transparent process, in other words a detailed technology, that aims to minimize bias through exhaustive literature searches of published and unpublished studies and by providing an audit trail of the reviewer's decisions, procedures and conclusions.*" The traditional reviews cannot be followed or replicated since the process is not described. The process of systematic literature review also ensures that the researcher goes through a sufficient number of publications and reduces bias.

2.1.1 Phases for conducting the systematic literature review

The systematic literature review process can be divided into three main stages. The first one is about planning the review. The second stage is about conducting the review. The last stage is reporting and dissemination. These different stages involve phases that are included in the process. (Tranfield, Denyer & Smart, 2003)

Fink (2019) suggests a different kind of model for performing a systematic literature review. The first step is choosing the research question (Fink 2019). Tranfield et al. (2003) propose that one should start a literature review by asking the experts what should be done in the review and how it should be scoped. There are problems related to the research question which might make it inappropriate for systematic literature reviews such as the question being too broad or vague. The other problems might be if good systematic literature reviews already exist or the scope is wrong. (Petticrew & Roberts, 2008)

The second step suggested by Fink (2019) is choosing the bibliographic databases and websites. This can be done by evaluating different databases and their publications. The database selection should be based on the scope of the study and research question. (Fink 2019) The systematic literature review aims to gain insight from all available research related to the research area. Therefore, the source of literature should be considered broadly to find the relevant literature (Petticrew & Roberts, 2008). The third step is choosing the right search terms (Fink, 2019). These might be words or phrases (Salminen, 2011). However, the search should consider synonyms or different spelling forms (Keele, 2007).

The next two steps regard the screening process of the review. The practical screening is about choosing the including or excluding criteria. This could include for instance publication language or type, choosing certain journals or authors, research design, or date of publication. The next screening is about methodological quality. This can be done by evaluating different parts of the study such as the publication's validity, data sources, or results. (Fink, 2019) The selection should result in literature that answers the review question (Denyer & Tranfield, 2009).

The sixth step is about doing the review. At this point, the actual data gathering process begins. (Fink, 2019) It is a critical step and can result in bias. It can be conducted by copying text or findings straight to the table or database. (Petticrew & Roberts, 2008) The last step is about synthesizing the results. There are multiple possible choices how this can be conducted such as in a descriptively manner or meta-analysis. (Fink, 2019) Narrative synthesis is also one option (Petticrew & Roberts, 2008).

When conducting a systematic literature review, one should use reference management software. Examples of these are Endnote or Reference Manager. Using reference software, the number of duplicates can be handled. The main benefit of the software is that it can help with tracking the papers. (Petticrew & Roberts, 2008) There are also other possibilities such as Zotero and RefWorks (KTDRR 2021a). For conducting systematic reviews, software, such as Covidence and SysRev, is available. These can be used to extract data from the publications and for the screening process. (KTDRR 2021b)

2.1.2 Benefits and disadvantages of systematic literature reviews

The benefit of systematic reviews is that the methodology is more defined and therefore the results are less biased. It is also a more transparent method compared to traditional reviews. This is because when the methodology is well explained, it can be replicated by following the steps, ending up with the same results. (Mallett, Hagen-Zanker, Slater & Duvendack, 2012) The results can show phenomena from different viewpoints (Keele, 2007). Therefore, it can result in viewpoints that the researcher has not even thought of. Also, it might increase the objectivity of the results (Mallett et al., 2012).

There are downsides to this method. First of all, the success of this approach heavily depends on the capabilities of the researcher (Pulsiri & Vatananan-Thesenvitz, 2018). This could be due to the incapability to choose the correct research string. This way it could leave out multiple relevant articles regarding the topic if authors use synonyms in their research papers. After defining the research string and going through some data, it will be based on a subjective opinion of the researcher if the paper is suitable to continue in the study. The used literature might be biased if the choice of literature fails (Salminen, 2011). One of the downsides is the amount of time that it consumes to conduct a literature review (Keele, 2007). The lack of suitable papers might lead to unsatisfactory results.

2.2 Bibliometric analysis as a research method

Bibliometrics is a statistical analysis of bibliometric data (Forsman, 2016). This method can also be used to make observations about qualitative matters for example using the high citation count as an indication of good article quality (Wallin, 2005). Bibliometric information that is usually found in scientific publications are citations, page numbers, authors, keywords, title, and publication year. Scientific publication is physical or electronic written material with scientific purposes such as reviews, books, and research notes. (Verbeek, Debackere, Luwel & Zimmermann, 2002).

Bibliometrics can have different aspects. It can for example focus on the authors, products, concepts, or citations. Bibliometrics aims to search the state of the art of research area, connections between publications, or indicators that resemble the effect of the different areas. Indicators can be divided in two different ways. The first is a quantitative number of publications or citations. These can be analysed by the development of the numbers or for example publications per author. The second is quality indicators such as the relative number of citations or impact factor. (Forsman, 2016) There are different kinds of impact factors available. In short, the impact factor could be calculated by dividing the citations by a certain time frame. (Wallin, 2005)

Bibliometrics, scientometrics, and informetrics are close terms to each other and they are used simultaneously. Bibliometrics are occasionally used to refer to all three different metrics. (Hood & Wilson, 2001) However, bibliometrics is a more specific term than scientometrics (Verbeek et al., 2002).

2.2.1 Common bibliometric methods

There are two main ways to conduct a bibliometric analysis. Science mapping can be done by analysing the relations between publications. Performance analysis uses the activity indicators such as volume, frequency, or citation analysis. (Noyons, Moed & Van Raan, 1999) Common methods for science mapping are co-citation and co-word analysis. (He, 1999) Other common methods are citation analysis, reference analysis, and bibliographic coupling (Forsman, 2016). The most common techniques of bibliometric techniques are listed in Table 2.

Table 2. Different bibliometric techniques (Cobo, López- Herrera, Herrera-Viedma & Herrera, 2011).

Bibliometric technique		Unit of analysis used	Kind of relation
Bibliographic coupling	Author	Author's oeuvres	Common references among author's ouevres
	Document	Document	Common references among documents
	Journal	Journal's ouevres	Common references among journal's ouevres
Co-author	Author	Author's name	Authors' co-occurence
	Document	Country from affiliation	Countries' co-occurence
	Institution	Institution from affiliation	Institutions' co-occcurence
Co-citation	Author	Author's reference	Co-cited author
	Document	Reference	Co-cited documents
	Journal	Journal's reference	Co-cited journal
Co-word		Keyword, or term extracted from title, abstract or document's body	Terms' co-occurence

Citation analysis, bibliographic coupling, and co-citation use citations as the basis of the analysis. Citation analysis can be done by simply calculating citation counts. The method is used to estimate the impact of authors, publications, or journals. The impact is calculated by different citation metrics. (Zupic & Cater, 2015) Bibliographic coupling measures how strongly the publications are related to one another for instance how many same references two different documents have in common (Wallin, 2005). The benefit of bibliographical coupling is that the information is available instantly and the analysis can be conducted with new publications without citations. The last method that uses citations is the co-citation analysis. It can be used to find the most influential publications in the area. (Zupic & Cater, 2015)

Co-author and co-word analysis use different information than the other methods. Co-author analysis uses the information about who are the writers of the publications. It aims to recognize the collaboration of different authors. However, it can be also used to identify collaboration between locations and institutions. Co-author analysis should be used to identify social networks. (Zupic & Cater, 2015) Co-word analysis is used to find the co-occurrence of different words. It falls under the content analysis category. (He, 1999) Co-word analysis can be used to analyse how science evolves. It uses the words to see which terms are usually used in the study area. Analysis shows the more established areas, but also the minor areas that can shape

the area over time. (Callon, Courtial, Turner & Bauin, 1983) These co-occurrences can have different indexes that show how related they are in the network such as inclusion and proximity index. (He, 1999)

Citation analysis differs from the co-citation and bibliographic coupling techniques. Citation analysis is used to find the most impactful publications, authors, and journals in their area of study. Bibliographic coupling and co-citation reveal the connectedness between different elements such as authors, journals, and publications. (Zupic & Cater, 2015) However, bibliographic coupling and co-citation are different even though they seem similar. Co-citation is about the citations in the same reference list, but the publication is coupled if they use the same reference. The other main difference is the co-citation amounts can grow when time passes. (Vogel & Güttel, 2013) The difference can be seen in Figure 1.

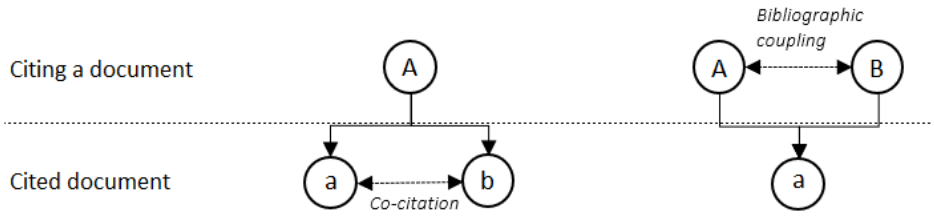

Figure 1. Co-citation and bibliographic coupling (Vogel & Güttel, 2013).

2.2.2 Software and databases for bibliometrics

There are multiple software that one can use for pre-processing such as Excel, BibExcel, and CiteSpace. They differ in their functions and which databases can be used to gain data. Some of the options have possibilities to pre-process the data. This includes de-duplication, time slicing, data reduction, and network reduction. (Cobo et al., 2011) BibExcel is described as a bibliometric toolbox that can be used to do most bibliometric analysis and develop maps. The data can be further processed in Excel or other software. There are multiple possible data sources for BibExcel if the data is in the right format. (Persson, Danell & Schneider, 2009)

CiteSpace is also capable of analysing and visualising data. It differs from BibExcel because it has time-slicing options (Cobo et al., 2011).

Some of the programs, lack in capabilities to visualise data, but the data visualization can be done in other software. However, it depends on the software used. Some of the software is mainly focused on visualisation such as VOSViewer. Other possible software there are Pajek and HistCite. (Cobo et al., 2011) For a bibliometric map, visualisation by VOSViewer is one good option. It can be used to understand emerging or declining topics.

The most commonly used databases are Web of Science, Scopus & Google Scholar for bibliometric data. There are also multiple other possibilities. The coverage of the databases differs. There are different written forms of names inside the databases, this will affect the results of the study if not corrected. (Forsman, 2016) Google scholar has more publications and citations than Web of Science and Scopus (Martín-Martín, Orduna-Malea, Thelwall & Delgado López-Cózar, 2018)

2.2.3 Benefits and disadvantages of bibliometrics

The usage of bibliometric analysis has been gaining popularity in recent years. There are multiple possible reasons behind this growth. One of the reasons behind this is the availability of tools that can be used to analyse the bibliographical information. (Ellegaard & Wallin, 2015) On the other hand, bibliometrics has been criticised due to a lack of standards (Glänzel, 1996). Moreover, to conduct bibliometric analysis, the area of interest needs to have enough publications (Zupic & Cater, 2015). The benefit of using bibliometrics is the amount of data that it can handle. It combines information to reveal otherwise invisible connections. Bibliometrics can be used to classify the relevant literature in a certain research area. (Zupic & Cater, 2015)

There are also some disadvantages related to bibliometric analyses as a research method. The citation counts are biased because the older publications have more time to be cited (Zupic & Cater, 2015) and the citation habits might vary depending on the field (Verbeek et al., 2002). This affects the results and can leave out impactful but newer publications. The citation counts

or other citation analyses do not indicate the way the reference is used in the text (Wallin, 2005). It can be used in a negative sense which does not imply the quality of the study, but only gets a lot of citations.

There may be data-related issues with using bibliometrics. Publications might miss some bibliometric data or there might be misspellings. Secondly, the coverage of the database might be unsatisfactory in different scientific fields. (Verbeek et al., 2002) The co-word analysis's downside is that the words can have different meanings and appear in different contexts. The co-author method might suffer from a lack of recognition for writers. (Zupic & Cater, 2015)

3. RESEARCH METHODOLOGY

In this chapter the applied methodology is explained in depth. First some reasoning is presented to explain why the chosen methodology is applied. Next, the applied systematic literature review process is briefly presented and illustrated in the figure. The different steps of the method are further discussed in more detail in separate paragraphs. The screening process that is one of the key steps is also discussed in more depth and visualized with another figure. In this chapter and following chapters the articles that was gathered is referred with the word sample.

3.1 Systematic literature review process

This study follows the systematic literature review process to minimize bias and get a better understanding of the topic. This way it was ensured that the researcher goes through a sufficient number of publications. Bibliometric mapping was chosen as a complementary method because it helps to find the structure of the research area (Ding, Chowdhury & Foo, 2001).

Systematic literature reviews are specifically useful to find different viewpoints how the topic is studied. Bibliometrics are complementary methods and help to find structure for the study area. Systematic literature review aims to answer specific question that forms the topic of the research. One of the bibliometric methods is co-word clustering and it is systematic way of showing articles and their relations. Even though it might exclude articles due to clarity or occurrences, it probably shows how the topic is evolving (Linnenluecke, Marrone & Singh, 2020). Author chooses the keywords of their paper. These keywords can be seen as description of the contents. When studying sample's keyword co-occurrence, it can reveal research themes and patterns (Ding et al., 2001). The co-word map forms the base for the conducted content analysis.

Figure 2 shows the research methodology. First, the research started with defining the purpose of the research. After, the search string was chosen and applied. Then results from the search go through screening and articles were either included or excluded in this study based

on the chosen criteria. The articles were imported to Mendeley for checking if the bibliometric information such as publication years was correct, and keywords were modified. Then, two analysis methods were used. The whole sample was used in the descriptive statistics. The co-occurrence map was formed and 50 of the 62 articles were related to each other with keywords. It included six different clusters. The clusters formed the base for the content analysis. Then the results were discussed, and conclusions were formed. It also includes suggestions for future research avenues.

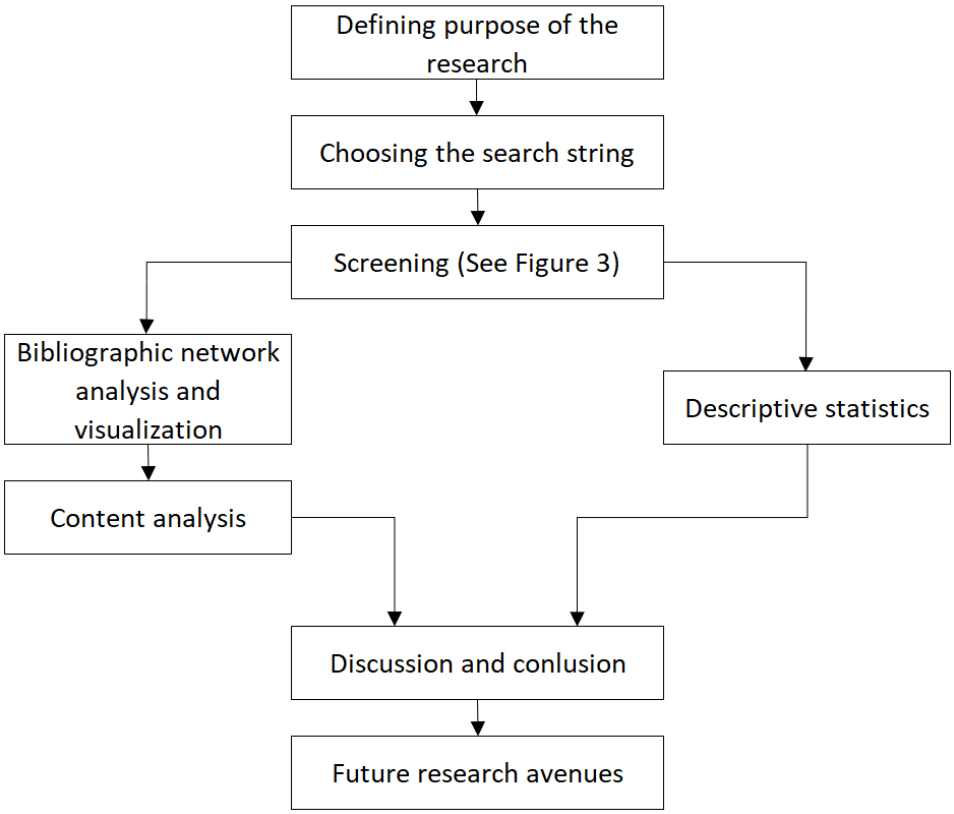

Figure 2. Systematic literature review methodology.

Defining the purpose of the research:

The purpose of the research is defined in the introduction. To analyse the disruption and performance link, the systematic literature review approach is chosen. This way the area can be studied more objectively than with the other literature review methods.

Choosing database and the research string:

Web of Science was chosen as a database for this research. It is one of the most used databases for systematic literature reviews. Search for articles was conducted while using the topic option. Therefore, the used words can be found in titles, abstracts, author keywords, and Keywords Plus. Data was gathered with the following search string:

"supply chain" AND disruption AND management AND performance.*

The search string helps to find suitable articles. The chosen words aim to reflect the study area. Supply chain and disruption as a research word is essential to find studies that focus on supply chain management and disruption. Because this study aims to find the performance impact of the disruptions, performance is used in the string. Asterisk is used in the disruption word to include the plural forms of this word. Management is added to keywords after an initial search without it and finding articles that focus more on other subjects than supply chain.

Other alternatives of research string were considered, but after testing out some other alternatives, it was a sufficient option. Searching from abstracts and the Web of Science's Keyword Plus helped with handling synonyms. Keyword Plus are words that appear in the article's reference list titles, but it re not included in the title (Clarivate, 2018). For example, some authors called supply chain disruptions with the alternative word of glitches, but the word was included in the Keyword Plus, so the article was included in the sample without including it in the string.

Screening:

The screening process is shown in Figure 3 below. The first result was 711 papers. The proceedings paper, review, book chapters, and editorial material were excluded from the results. This left out 143 articles. The publication year was set to a ten-year time frame from 2011 to 2020. The year 2021 was excluded because the search was conducted at the beginning of the year 2021. This limited the data to 505 articles. Only articles written in English were included, excluding 2 articles. The last exclusion criteria were the early access articles due to possible

problems with Mendeley. A sample of 481 articles was extracted from the database for further processing.

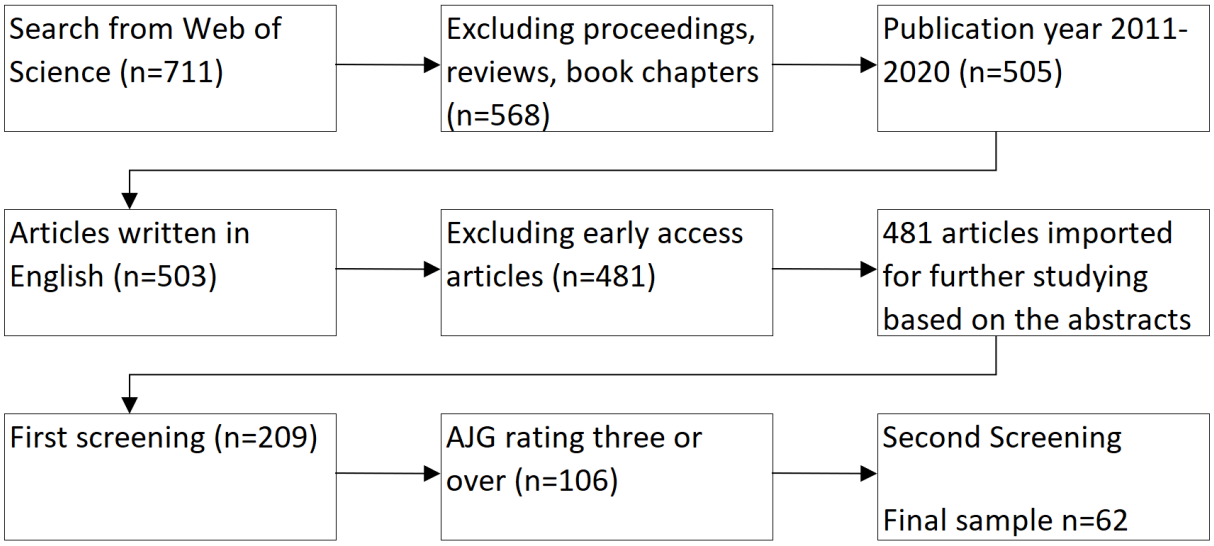

Figure 3. Screening process.

The articles were imported to Mendeley to help with the process of going through the abstracts. The process started with reading through the articles' abstracts and based on the information the article was chosen for the study or removed. Articles were chosen to continue after this step if they studied the impact of disruptions on performance in some way. After the first screening of abstracts, there were 209 articles left to study. The first screening contained articles that could not be clearly excluded from this study by reading through the article's abstract.

Articles that had an AJG rating over two were included in this study. 106 articles were chosen for the next screening step. In the second screening, the articles were either accepted based on the abstract or the whole article was used to evaluate if the article was eligible for this study. This left out a sample of 62 articles. The articles were studied to confirm that they have the correct information about publication years and so on. They were fixed if there were any problems. The list of included articles is presented in Appendix 1.

Descriptive statistics, clustering, and content analysis:

Descriptive statistics were used to understand the formed sample and they were formed with the help of Excel. From there, Conclusions were drawn on how the research area is evolving and who are the most productive authors. It also included some insights about the most impactful articles, authors, and journals. Keyword frequencies were also analysed.

The content analysis of the articles included deductive and inductive approaches. The coding was done with keyword clustering. With the help of VosViewer, a keyword map was formed. A keyword map is formed based on the co-occurrences. If a keyword occurs at least twice it forms a node. If there is a link between the nodes, it signifies that the two keywords have appeared in the same article (Van Eck & Waltman, 2014). Only keywords that authors have used were used in clustering and some keywords were deleted such as supply chain. 50 of the 62 articles were related to each other with keywords and resulted in six clusters. The clusters form the base for further analysis. Because the keywords describe the article's research area the co-occurrences of keywords suggest the same or similar subject between the articles. Articles that were included in the content analysis were studied, synthetizing the themes and findings.

3.2 Delimitations of this study

Delimitations of this study were related to the methods used. The first limitation was regarding the database chosen. Only articles from the Web of Science were used in this study. This might have left out numerous articles. The data collection affected the results in multiple ways. The process started with choosing the selection of words that were used in the data collection. This might have led to exclusion of articles that do not use those certain terms even though the topic option was used in the search. If the article used for example synonyms it might have been excluded.

The other delimitations of this study were related to the screening process. Firstly, the research was only limited to scientific articles found in the Web of Science database. Secondly,

the found articles were filtered in multiple ways. The chosen articles had to be written in English. The year 2021 was excluded from the research because the search was conducted at the beginning of the year 2021. The articles were mainly chosen by reading the abstracts and if needed reading through the article. If the article was missing an abstract or the abstract did not include information regarding the chosen area, it was excluded from the study. These delimitations were done to achieve the best possible results from this study, but the selection of articles and the screening process could have led to bias since they were based only on subjective opinion. After clustering the content analysis was based on subjective opinion.

Choosing the AJG rating as one of the exclusion criteria leads to bias according to Linnenluecke et al. (2020). They point out that one should criticise if the quality is lacking in some way. However, it was a necessary step for this study because this is a bachelor thesis, and the writer does not yet have the capabilities to evaluate for example the goodness of applied methodology.

4. RESULTS

This section is divided into two parts. The first section will discuss the statistics of the sample articles. It contains information about publication years, popular journals, citations, author keywords, and authors. The article selection was explained in the previous section. The number of citations was collected in late November from Web of Science. The descriptive statistics were formed and visualized by Excel. The second part is analysing the content of the clusters. The clusters were formed based on keywords using the software VosViewer. From the sample 50 articles were related to each other with keywords.

4.1 Descriptive statistics

The dispersion of publishing years and citations is presented in Figure 4. The first four years contained only ten articles. There is a peak in the publications in the year 2015. After that, the amount is fairly stable in the next five years. There is a drop in the year 2017. The year 2020 represents 22,6 % of this sample. It might be due to the impact of covid-19 which was a worldwide disruption. There seems to be steady growth in the articles over the years. There are no citations in the year 2011. In 2012–2013, there is a small growth in citations. After that, the number of citations has almost doubled every year except for the year 2017. The research area has received more attention than in the previous years based on the number of published papers and times cited.

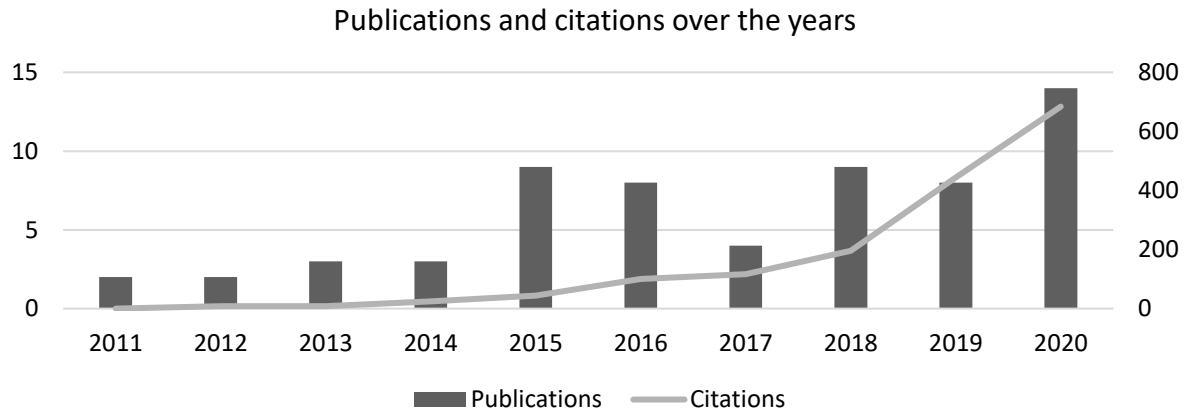

Figure 4. Publications and citations distributed over time.

Figure 5 shows the most common keywords and their frequencies. In this sample, there were 210 unique keywords and 34 of them occurred more than once. Supply chain disruption (14) has been the most used keyword, which makes sense since this sample is about disruptions. Similarly, the term disruption (10) has received a lot of attention. Keywords can be used to understand the research area (Chen, Liu, Luo, Webber & Chen, 2016). Based on the results three management areas have received the most attention and they are supply chain management (11), disruption management (9), and risk management (8). Four keywords focus on supply chain features which are resilience (8), dynamics (6), design (4), and robustness (3). Surprisingly, supply chain design was the keyword of only four articles. However, the other supply chain features can be more informative even though they might include supply chain design decisions such as improving resilience with alternative sources of supply.

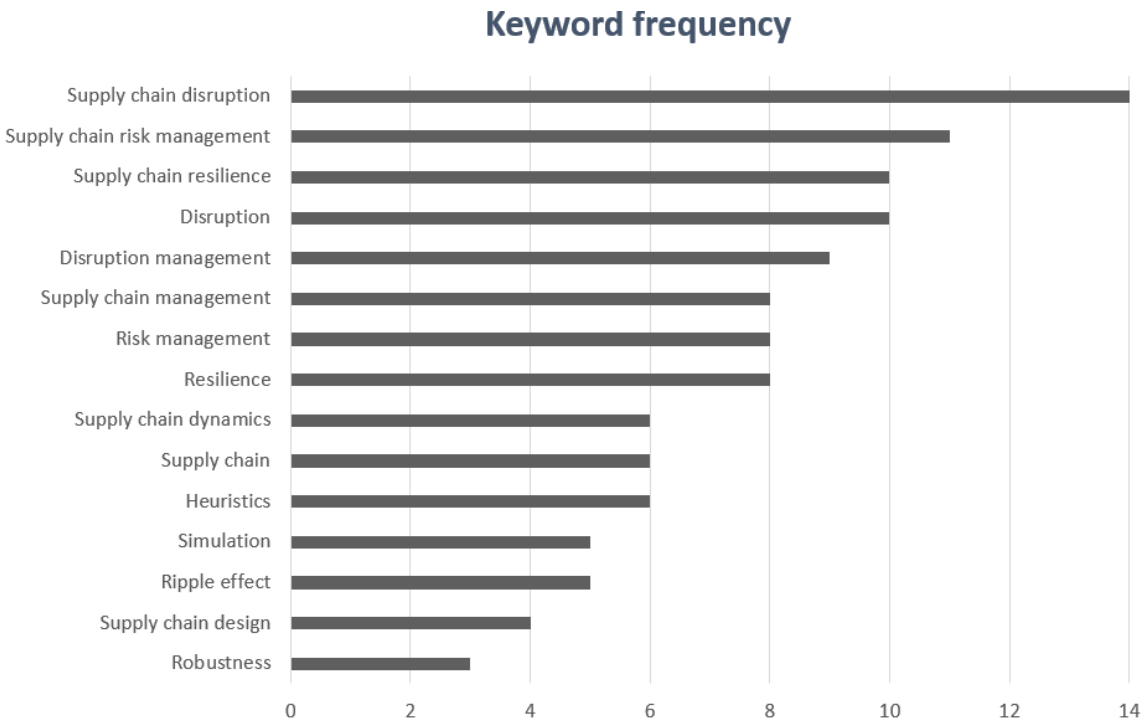

Figure 5. Keyword frequency.

Table 3 shows the authors who have published at least 2 articles. It also shows the total number of their articles and how many times their articles have been cited. The sample contained 153 unique writers. Only 14 have contributed more than one paper. The most productive writer has been Dmitry Ivanov who has contributed to 10 articles meaning that he has contributed to 16,1 % of all papers in this study. He was also the most impactful author based on the citation count. Alexandre Dolgui and Boris Sokolov are the second and third biggest contributors. All their papers have been published with co-authorship with Dmitry Ivanov.

Table 3. Authors, number of publications, and times cited.

Author	Articles	Times cited
Ivanov Dmitry	10	1057
Dolgui Alexandre	7	536
Sokolov Boris	6	476
Blackhurst Jennifer	4	134
Parast Mahour	4	122
Paul Sanjoy	4	101
Pavlov Alexander	3	202
Azadegan Arash	2	46
Essam Daryl	2	41
Hosseini Seyedmohsen	2	138
Jabbarzadeh Armin	2	53
Macdonald John	2	116
Nooraie Vahid	2	76
Sarker Ruhul	2	41

Table 4 shows the journals sorted in descending order by the count of articles. There are two main journals, which are the *International Journal of Production Research* and the *International Journal of Production Economics*. They have published 56,5 % of articles in this sample. When looking at the mean of citations the differences are not that huge between the journals. The only exception is *Transportation Research Part E: Logistics and Transportation* which has a high mean of citations. However, it is due to one impactful paper from Dmitry Ivanov.

Table 4. Journals with the number of published articles and citations.

Journal	Articles	Times cited	Mean of citations
International Journal of Production Research	20	950	48
International Journal of Production Economics	15	531	35
Supply Chain Management: An International Journal	4	113	28
Transportation Research Part E: Logistics and Transportation	4	564	141
Decision Sciences	4	130	33
IEEE Transactions on Engineering Management	3	115	38
Annals of Operations Research	3	79	26
Management Science	2	43	22
Computers & Operations Research	2	84	42
Transportation Research Part B: Methodological	1	29	29
European Journal of Operational Research	1	25	25
Operations Research	1	20	20
Manufacturing & Service Operations Management	1	15	15
Reliability Engineering & System Safety	1	29	29

The most impactful articles are listed in Table 5. The impact is measured by citation count. The clear leader is Dmitry Ivanov's paper which studies the impact of epidemic disruptions on supply chain performance. It has received the most attention even though it was published last year. The second paper in the list is a literature review of the ripple effect by Alexander Dolgui, Dmitry Ivanov, and Boris Sokolov. After the second paper in the list, there is no huge difference between the citations in the following three papers. However, the fourth paper has been recently published and it discussed supplier selection and proposed a model to evaluate the correct strategy for supplier selection. Four papers have been published in two of the most impactful journals in the sample. One is published in *Transportation Research Part E: Logistics and Transportation*. Dmitry Ivanov's paper represents over 71,6 % of the citations of that journal in this sample.

Table 5. Impactful articles with authors, titles, and journals.

Times cited	Authors	Article	Journal
404	Dmitry Ivanov (2020)	Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case	Transportation Research Part E: Logistics and Transportation
202	Alexandre Dolgui, Dmitry Ivanov, Boris Sokolov (2018)	Ripple effect in the supply chain: an analysis and recent literature	International Journal of Production Research
112	Anand Nair, Jose Vidal (2011)	Supply network topology and robustness against disruptions - an investigation using multi-agent model	International Journal of Production Research
91	Seyedmohsen Hosseini, Nazanin Morshediou, Dmitry Ivanov (2019)	Resilient supplier selection and optimal order allocation under disruption risks	International Journal of Production Economics
86	Dong Lei, Jianbin Li, Zhixue Liu (2012)	Supply chain contracts under demand and cost disruptions with asymmetric information	International Journal of Production Economics

4.2 Results of content analysis

Keyword clustering was done with the help of VosViewer. The resulting keyword map is presented in Figure 6 on the next page. There were 62 articles and 50 were related to each other with keywords. A link between two nodes is formed if the keywords occur in the same article (Van Eck & Waltman, 2014). There are six different clusters, and they are labelled by different colors. The colors of the clusters are assigned randomly. A bigger node implies higher occurrences of the keyword. The distance between two nodes significates the strength of the relation (Van Eck & Waltman, 2014).

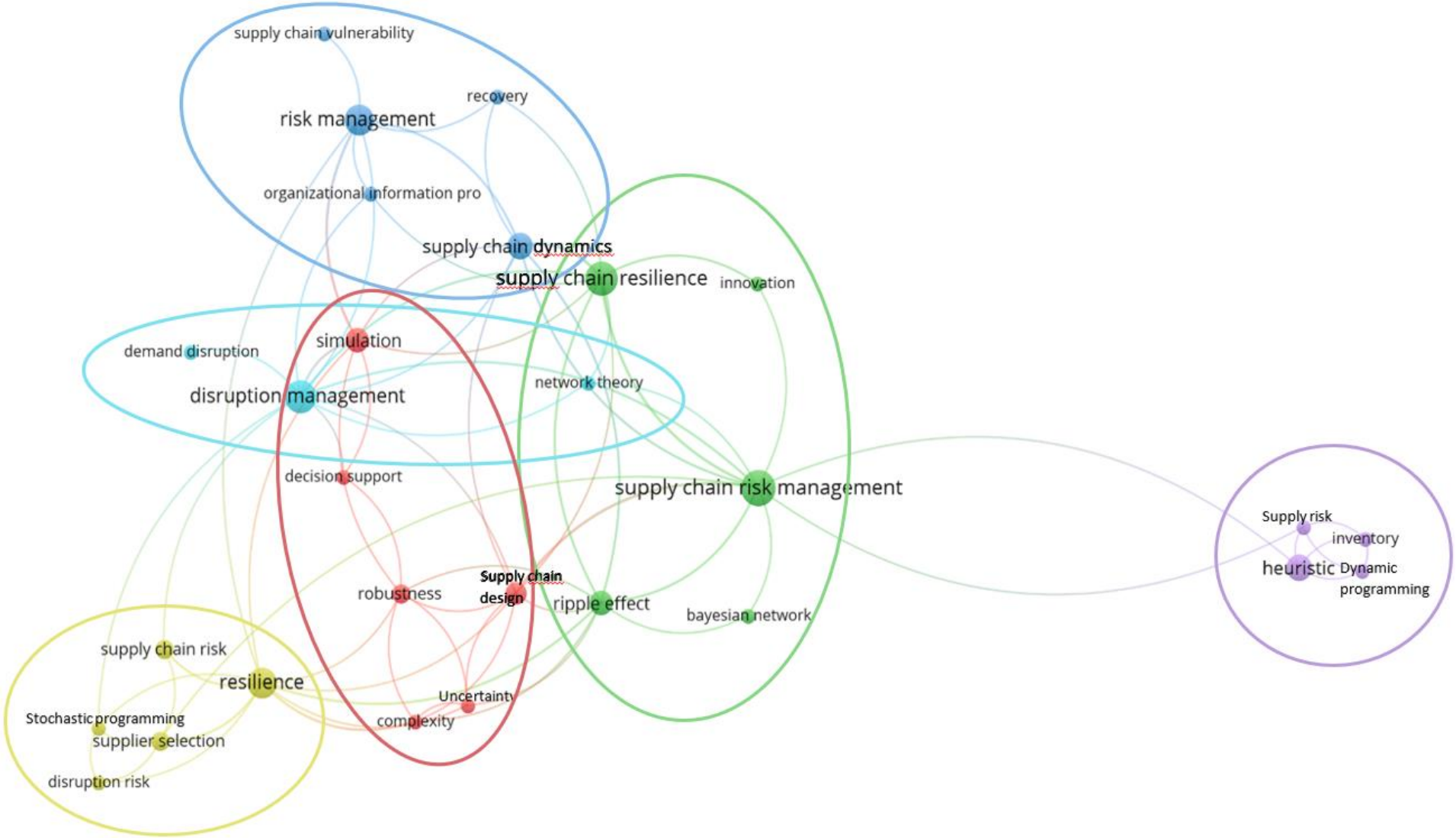

Figure 6. Keyword map.

Blue cluster – Supply chain dynamics:

There were 15 related articles and 5 keywords: organizational information processing theory, recovery, risk management, supply chain dynamics, and supply chain vulnerability. This cluster was more focused on what happens after disruption for example supply chain recovery (Chen, Liu & Yang, 2015; Ivanov, Pavlov, Dolgui, Pavlov & Sokolov, 2016) or damage control (Azadegan, Syed, Blome & Tajeddini, 2020). The disruption might lead to a dynamic and uncertain environment for a time. Structural dynamics can be a source of a ripple effect. Understanding the ripple effect and propagation can help to assess which suppliers or supply chains are critical (Hosseini et al., 2020; Kinra et al., 2020).

Peng, Peng, and Chen (2014) studied inventory and logistics planning in a post-seismic environment when some of the road conditions might change. Their findings point out that information sharing is important in case of seismic disruptions. It seems like the recovery should be about speed because the robustness is increased if supply chain members apply radical recovery strategies (Chen et al., 2015). However, timely management of echelons is important because it might mitigate the impact of disruption (Ivanov, 2020). Ivanov et al.'s (2016) model can be used to analyse supply chain replanning with recovery strategies. Sharing information with blockchain technology might shorten the recovery time (Lohmer et al., 2020). Ivanov and Sokolov (2019) considered the resilience of the supply chain with recovery control. Their model assessed the changes in supply chain design and delivers suggestions on how supply and demand could be allocated better.

Business continuity management had received some attention. Azedegan, Parast, Lucianetti, Nishant, and Blackurst (2020) considered how business continuity programs with two different response strategies can decrease the performance impact of disruptions. They conducted two studies that one was based on subjective experience and financial performance. The other was a Vignette-based experiment that tested hypothetical situations and implemented a post hoc analysis. The empirical results were contradictory between the studies. The first study showed that flexibility orientation in case of disruption might make disruptions more harmful

due to the possibility of improvising and in the other one, there were no support for this statement. The conclusion was that combining procedural and flexibility orientation strategies might lead to the best performance, not only in case of disruption. Business continuity management with and without supply chain involvement might be beneficial to damage control (Azadegan et al., 2020). Supply chain involvement in business continuity management is beneficial in limiting the negative effect of disruption. Similar effects can be seen with reputational damage and business continuity management.

Purple cluster – Optimization under disruptions:

The smallest cluster of them all, seven articles were related, and four keywords covered: dynamic programming, heuristics, inventory, and supply risk. This cluster was mainly focused on recovery planning. Recovery planning is important to minimize the effect of disruptions (Paul, Asian, Goh & Torabi, 2019). The recovery plans were mainly focused on the optimization of the amount of safety stock (Paul & Rahman, 2018) with one exception which focused on a lean supply chain with zero safety stock (Paul et al., 2019). The focus of these articles are operational disruptions such as machine breakdowns (Paul, Sarker & Essam, 2015), supply delay (Paul & Rahman, 2018), supply risk (Gao, 2015; DeCroix, 2013), and transportation disruption (Paul et al., 2019).

Paul et al. (2015) study recovery planning under multiple disruptions. Paul and Rahman (2018) studied a recovery model and tested out how changing various parameters change the results of the proposed model. Safety stock is important from recovering supply delays. Paul et al. (2019) studied the optimal recovery model under transportation disruptions without safety stock. Gao (2015) studied the optimal inventory hedging strategy under disruptions. Gao (2015) bases proposed optimal mitigation strategy on forecasting the signs that might indicate looming disruptions. The results of the study by Gao (2015) suggested that information sharing might aggravate supply disruptions if there were no contract coordination. Supply disruptions were more costly when the supplier has a shorter lead time versus a longer lead time according to DeCroix's (2013) study. This finding could be beneficial when choosing the mitigation strategies such as a backup supplier or developing a current supplier (DeCroix, 2013).

Red cluster – Supply chain design:

The red cluster has 13 related articles and 6 keywords: complexity, decision support, robustness, simulation, supply chain design and uncertainty. The articles were focused on supply chain design. The supply chain design decisions can be used to mitigate disruptions i.e., with building redundancy (Clemons & Slotnick, 2016), location of the suppliers (Habermann, Blackhurst & Metcalf, 2015), or inventory allocation (Nair & Vidal, 2011). Ivanov (2020) studied the supply chain design under epidemic disruptions. According to their simulation, the effect on supply chain performance is lesser when the recovery of facilities is synchronized. Habermann et al. (2015) found out that co-locating suppliers might mitigate disruption duration. Clemons and Slotnick (2016) studied allocating supply between two suppliers taking into consideration quality and knowledge transfer. Zhao, Scheibe, Blackhurst, and Kumar (2019) developed a model that can be used to evaluate the robustness of the existing or possible supply chain network designs. Nair and Vidal (2011) studied robustness and different supply network topologies with different path lengths between clusters. They found out that a shorter average path between nodes is beneficial for robustness. Information management has significance in mitigating the disruption risk, but also has an impact on recovery (Yang & Fang, 2016).

The recovery from the disruption is prioritized in contingency strategies such as operation flexibility (Sokolov, Ivanov, Dolgui & Pavlov, 2016) or opening or closing facilities (Ivanov, 2020). Sokolov et al. (2016) developed a model that can assess the resilience of different supply chain designs. They found out that supply chain designs with the ability to implement contingency plans might be more efficient than opening alternative facilities. Tan, Cai, and Zhang (2020) found out that contingency strategies are more suitable for short-term disruptions. Supply chain design decisions can also be used to build resiliency. Birkie, Trucco, and Campos (2017) studied how supply chain complexity affects resilience and performance in case of disruption. They found that recovery performance can be positively affected by complexity. Also, the resilience capabilities are beneficial for recovering from disruptions according to their study.

Green cluster – Supply chain risk management:

The green cluster includes 21 articles and has 5 keywords: Bayesian network, innovation, ripple effect, supply chain resilience, and supply chain risk management. The articles were about risk management practices in supply chain management. The focus is the evaluation of different supply chain designs and how they affect performance in case of disruptions. Kinra, Ivanov, Das, and Dolgui (2020) focused on the consequences of the ripple effect as the maximum possible loss. Their model can be used to identify high-risk suppliers in terms of possible loss. Pavlov, Ivanov, Dolgui, and Sokolov's (2018) model included the effect of structure reconfiguration such as which suppliers will be interrupted or survive disruption and at what point the supply chain will stop working completely. Their work can be utilised to compare different supply chain designs on their resilience capabilities and to find supplier groups that might interrupt the supply chain. Hosseini, Ivanov, and Dolgui's (2020) model studied the ripple effect and can be used to find critical paths in supply chain design. Mizgier, Wagner, and Juttner's (2015) model can calculate the loss of distribution on supply chains from disruptions. Hossain, El Amrani, Jaradat, Marufuzzaman, Buchanan, Rinaudo, and Hamilton (2020) assessed the effects of port disruptions on the entire supply chain. They found out that supplier responsiveness is important to supply chain performance if there is a port disruption.

Some of the articles assessed the recovery from disruption. Ivanov, Sokolov, Solovyeva, Dolgui, and Jie (2016) developed a model that can be used to analyse different recovery policies for a time-critical supply chain. Ivanov and Sokolov's (2019) model can be used to evaluate the performance impact of applied recovery policies and develop recovery strategies even further.

Some papers discussed different factors that could mitigate the impact of disruption such as investments in supply chain capabilities (Nooraie & Parast, 2016) and R&D investments (Parast, 2020). Nooraie and Parast's (2016) findings suggested that investments in supply chain capabilities might reduce the total cost of supply chain disruption. Parast (2020) found out that investment in research and development decreases the negative performance impact of demand, process, and supply disruption on a company’s performance. A similar effect can

be found affecting supply chain performance in case of process or environmental disruption (Parast, 2020).

There are few papers that discussed different disruption mitigation strategies such as postponement (Carbonara & Pellegrino, 2018), location of suppliers (Habermann et al., 2015), and inventory allocation (Gao, Simchi-Levi, Teo & Yan, 2019). Carbonara and Pellegrino (2018) discussed a postponement as a strategy to mitigate the impact of supply and demand disruptions. Their model can assess that whether postponement is a valuable option when supply or demand disruptions happen. Gao et al. (2019) included disruption probability estimates into their model. It can help to understand where to allocate excess inventory as a disruption mitigation effort. Habermann et al. (2015) pointed out that longer lead times result in higher disruption risk.

Strategies to build resilience had also received attention. Lohmer, Bugert, and Lasch (2020) studied how blockchain technology affects resilience strategies. They found out that resiliency is positively affected, and the impact is greater when the supply chain is more integrated. Tan et al.'s (2020) model can be used to evaluate different mitigation or contingency strategies to build resilience in existing supply chains. Both strategies decreased the total cost of disruption impact. Supply chain resilience has been found to positively impact financial performance in case of supply disruptions (Wong, Lirn, Yang & Shang, 2020).

Yellow cluster – Decision-making tools:

There were 12 related articles and five keywords: Disruption risk, resilience, stochastic programming, supplier selection and supply chain risk. This cluster was mainly focused on decision-making problems and optimization considering supply chain design (Sokolov et al., 2016; Sabouhi, Jabalameli, Jabbarzadeh & Fahimnia, 2020), recovery policies (Ivanov et al., 2016), supplier selection (Sawik, 2016; Hosseini, Morshedlou, Ivanov, Sarder, Barker & Al Khaled, 2019), resilience (Birkie et al., 2017; Macdonald, Zobel, Melnyk & Griffis, 2018) and routing problem (Cho, Lim, Kim & Biobaku, 2018). Some optimization models considered resilience as

their metric and how agility and flexibility affect responsiveness and mitigate disruptions (Shekarian, Nooraie & Parast, 2020). There are two ways a disruptive event can be handled. Parametrical adoption is about changing parameters such as lead-time and structure adaptation is changing to contingency plans or others. (Ivanov et al., 2016)

Ivanov (2020) studied epidemic outbreak disruptions and their impact on supply chain performance. The performance impact depended mainly on the timing and propagation of the disruption as well as the closing of facilities (Ivanov, 2020). Improvement in flexibility seems to be a better mitigation strategy than improving agility in supply chains (Shekarian et al., 2020). Macdonald et al. (2018) proposed a framework that can be used to investigate how resilience affects supply chain performance. Some of the articles covered the topic of measuring the performance of supply chains such as resilience (Munoz & Dunbar, 2015). However, those performance metrics are helpful for decision-making processes, because based on data one can do choices and evaluate what the outcome might be.

The minimization of supply chain complexity is often preferred by decision-makers (Birkie et al., 2017). According to their study, supply chain complexity should not necessarily be minimized, because complexity might have a positive effect on recovery from supply chain disruptions. On the contrary, Bode and Macdonald's (2017) results suggested that the complexity makes it harder to identify and diagnose the disruption due to the amount of information from complex supply chain networks. However, when the disruption is identified and diagnosed, there is no longer a negative effect from complexity (Bode & Macdonald, 2017).

Turquoise cluster – Disruption management:

Disruption management is one of the smaller clusters, only 11 articles are related and three different keywords covered: disruption management, demand disruption and network theory. The focus of this cluster was disruption management. There were three main directions of research in this cluster which are network related (Blos, da Silva & Wee, 2018; Mizgier et al., 2015; Pavlov et al., 2018; Tan et al., 2020), information management (Yang & Fan, 2016; Lei, Li & Liu, 2012) and decision-making support (Cao, Zhou & Lu, 2015; Cho et al., 2018; Bode &

Macdonald, 2017). The disruption management can be understood as the management of the situation under disruptions from discovering the disruption to the recovery process and learning from the process (Macdonald and Corsi, 2013). Disruption management contains four common decision response stages: recognition, diagnosis, development, and implementation (Bode & Macdonald, 2017). The most important stages in terms of reducing the impact of disruption are recognition and response implementation according to Bode and Macdonald's (2017) study.

Tan et al. (2020) compared mitigation and contingency strategies in case of disruptions. Contingency strategies perform better cost-wise. However, mitigation strategies have a lower time to recover from disruptions. This suggested that contingency strategies are better for short-term disruptions. (Tan et al., 2020)

Some directions in this area of study can be identified such as loss of distribution in supply chain networks due to different disruptions (Mizgier et al., 2015), resilience with ripple effect and structure reconfiguration (Pavlov et al., 2018), and information management strategies to mitigate disruption risks (Yang & Fan, 2016). Pavlov et al. (2018) studied resilience under ripple effect in the supply chain network. Their work can be used to analyse the different nodes that cannot survive the disruptions and therefore used to identify critical parts of the supply chain network. Blos et al. (2018) presented a framework that can be used to disruption management to improve global supply chains robustness. They take into account the carrier viewpoints and productive systems.

Yang and Fan (2016) evaluated information management strategies with the magnitude of the bullwhip effect as the performance metric. By comparing traditional, information sharing, and collaborative planning, forecasting, and replenishment supply chains, they found out that the latter performs the best under disruptions with complete information in terms of fastest recovery. Lei et al. (2012) found that the asymmetric information of disruptions might lead to problems with production plans and have an effect on supply chain performance. Cao et al. (2014) argued that the production plans should be re-evaluated after disruptions if they affect market demand or production costs.

Different disruptions have different characteristics with different effects. Demand disruptions might increase the retailer's risk in two ways: stock-out or overflow of inventory if the demand is suddenly declined (Ji, Sun & Wang, 2017). Manufacturer benefits from demand shock if the market is highly profitable through retailers' bigger orders to avoid stockouts (Ji et al., 2017). Based on demand disruptions characteristics, Ji et al. (2017) suggested transhipment before buyback contracts. According to Mizgier et al. (2015), the effects of disruptions should be collected to a database that could be used to evaluate the risks and effects. Bode and Macdonald (2017) agreed on the importance of information collection from disruptions.

5. DISCUSSION AND CONCLUSIONS

Sub-research questions dealt with more descriptive statistics of the sample, and one can draw some conclusions about how the research area is evolving. There was clear concentration to certain authors and journals. The growth in citations and published papers show that the area is receiving more attention. Since the covid-19 is still here, it is no wonder that it piques interest. Considering the current situation with the coronavirus situation understanding disruptions becomes even more important. Even though one could argue that Covid-19 is a source for dynamics, but the effect can be disruptive for a long time.

Even though the chosen articles discussed the effect of disruptions on a company's performance, there were not so many clear answers to the main research question: *How do supply chain disruptions affect companies' performance?* The sample answered more questions about how the effects of disturbances can be mitigated. Also, the sample answered what can mitigate or amplify the impact of the disruption. They answer the main research question, but in a slightly different way. One of the reasons why there were not too many results answering the question how was that there was a clear lack of empirical data in this sample. Only a few of the studies contained a real-life dataset, and they mainly contained only subjective data from questionnaires.

There was a clear focus on supply chain design. The key of finding what kind of impact the disruption has is to understand what suppliers are most affected by the disruption. Some suppliers are critical to the company itself and might form critical paths. Many articles, therefore, deal with the design of supply chains and seek to understand these high-risk suppliers to make more resilient or robust supply chains. Evaluating the riskiness of suppliers is one way to approach the effect of disruptions. The maximum possible loss as a consequence of disruption is also another way to find high-risk suppliers.

Supply chain design can have different objectives and usually, the decisions are made based on cost or service level. However, besides the cost, the design can be used to aim to decrease complexity or improve agility. When designing supply chains, it is possible to consider the effect of disruptions or the disruption risks in general. There were multiple models that could

be used to either understand the current or other alternative supply chain designs. If they considered the current design, they assessed the impact of different kinds of disruptions. Usually, the models found the critical paths or critical suppliers that might disrupt the supply chain entirely. A similar focus can be seen in the models that considered other possible alternatives and they are able to evaluate two different designs for example in terms of resilience against disruptions or total costs. With these models, the supply chain design can be built to be more resistant to disruptions. These models usually contain information where one should invest in to mitigate the impact of disruption. This can be used for example to build redundancy such as inventory or alternative sources of supply for critical suppliers.

Different strategies against and to recover from the disruptions are also covered. Some of these articles discussed the contingency strategies, which can be used to recover from supply chain disruptions. The strategies can be used to build resiliency in the supply chain and decisions in general. One of the interesting findings is that in case of epidemic outbursts, it is important to understand how the opening and closing of the facilities have a huge importance in decreasing the impact of the disruption. Information sharing can either be harmful or beneficial in case of supply chain disruption. It can be a source of uncertainty which makes the supply chain behave in certain even in a harmful way.

5.1 Managerial implications

There are some implications for practical use. One of them is taking into consideration supply chains' complexity. For mitigating the performance impact of disruption some level of complexity in a supply chain design should conserved such as an alternative source of supply from a local supplier. The complexity of supply chain design makes it harder to identify the source of disruption which might have a huge impact in controlling the negative impacts. Therefore, if a company has complex supply chains, it should invest capabilities to locate disruptions. These could be for example advanced information sharing between companies.

Information sharing and management have also some implications. Information management is a delicate issue that should be preplanned carefully what to do in case of a disruption. Information might have different impacts on the supply chain under disruptions. In some cases, it can prevent the disruption from happening and therefore stop the ripple effect from happening. It can also have a counterproductive impact and even cause disruption. Sometimes, the disruption could be handled without any measures, but actions cause the negative effect to take place.

5.2 Limitations and suggestions for future research

There is a possibility that the research results might be biased due to including only articles that have an AJG rating of three or over. It might be that highly rated journals only include new theoretical approaches but not practical points of view. Therefore, there is a possibility that articles that study the area with case studies or similar might be excluded. The base of the content analysis was formed with a keyword co-occurrence network. There seem to be some differences in the used terminology. For example, according to Ribeiro and Barbosa-Povoa (2018), resilience definition has not reached a consensus among researchers. It might have an impact on the results of this research since only one research string was used.

Supply chain disruptions have different characteristics depending on what causes the disruption. Mainly the models discuss only disruptions in general and how to design supply chains against disruption. As previously discussed, the disruption characteristics such as epidemic have an impact on recovery or performance in general. Another viewpoint that is articles rarely take into consideration product specifications. If a product is perishable or seasonal disruption recovery and management includes different features than non-perishable products. For further research, the product specifications should be considered even more.

There is a clear lack of empirical investigations. Most of the articles are models that would be important to test empirically. This is probably due to the fact that the disruption data is difficult to obtain because it is mainly internal information and rarely available to researchers. This might be the reason why the performance impact of disruptions has not been directly studied

and it leaves room for future studies. Some of the studies that tested empirically the effect of disruption used data from surveys. The performance impact of disruption is hard to evaluate objectively (Azadegan, Parast, Lucianetti, Nishant & Blackhurst, 2020) since the main goal is to survive the disruption. Even though the company survives the disruption, it does not mean that it performed in the best way possible. Therefore, subjective opinion should not be the main way of studying the disruption impact. This calls out for future research based more on objective performance measures such as financial performance or combining both measures when studying the performance impact of disruptions.

REFERENCE LIST

Azadegan, A., Mellat Parast, M., Lucianetti, L., Nishant, R., & Blackhurst, J. (2020) Supply chain disruptions and business continuity: An empirical assessment. *Decision Sciences*. 51 (1), 38-73.

Azadegan, A., Syed, T. A., Blome, C., & Tajeddini, K. (2020) Supply chain involvement in business continuity management: effects on reputational and operational damage containment from supply chain disruptions. *Supply Chain Management: An International Journal*. 25 (6), 747–772.

Barroso, A. P., Machado, V. H., Barros, A. R., & Machado, V. C. (2010) Toward a resilient supply chain with supply disturbances. In *2010 IEEE International Conference on Industrial Engineering and Engineering Management.* 2010 IEEE. pp. 245-249.

Beamon, B. M. (1999) Measuring supply chain performance. *International journal of operations & production management.* 19 (3), 275-292.

Birkie, S. E., Trucco, P., & Campos, P. F. (2017) Effectiveness of resilience capabilities in mitigating disruptions: leveraging on supply chain structural complexity. *Supply Chain Management: An International Journal*. 22 (6), 506–521.

Bode, C., & Macdonald, J. R. (2017) Stages of supply chain disruption response: Direct, constraining, and mediating factors for impact mitigation. *Decision Sciences*. 48 (5), 836-874.

Bode, C. & Wagner, S. M. (2015) Structural drivers of upstream supply chain complexity and the frequency of supply chain disruptions. *Journal of operations management.* 36 (1), 215–228.

Bottani, E., & Montanari, R. (2010) Supply chain design and cost analysis through simulation. *International Journal of Production Research*. 48 (10), 2859-2886.

Blos, M. F., da Silva, R. M., & Wee, H. M. (2018) A framework for designing supply chain disruptions management considering productive systems and carrier viewpoints. *International Journal of Production Research*. 56 (15), 5045-5061.

Callon, M., Courtial, J. P., Turner, W. A., & Bauin, S. (1983) From translations to problematic networks: An introduction to co-word analysis. *Social science information*. 22 (2), 191-235.

Cao, E., Zhou, X., & Lu, K. (2015) Coordinating a supply chain under demand and cost disruptions. *International Journal of Production Research*. 53 (12), 3735-3752.

Carbonara, N., & Pellegrino, R. (2018) Real options approach to evaluate postponement as supply chain disruptions mitigation strategy. *International Journal of Production Research*. 56 (15), 5249-5271.

Carvalho, H., Barroso, A. P., Machado, V. H., Azevedo, S., & Cruz-Machado, V. (2012) Supply chain redesign for resilience using simulation. *Computers & Industrial Engineering*. 62 (1), 329-341.

Chen, D., Liu, Z., Luo, Z., Webber, M., & Chen, J. (2016) Bibliometric and visualized analysis of emergy research. *Ecological Engineering*. *90*, 285-293.

Chen, L. M., Liu, Y. E., & Yang, S. J. S. (2015) Robust supply chain strategies for recovering from unanticipated disasters. *Transportation Research Part E: Logistics and Transportation Review*. 77198-214.

Cho, J., Lim, G. J., Kim, S. J., & Biobaku, T. (2018) Liquefied natural gas inventory routing problem under uncertain weather conditions. *International Journal of Production Economics*. *204*18-29.

Clarivate. (2018) Keyword plus generation, creation and changes. [www document]. [Accessed 27 December 2021]. Available: https://support.clarivate.com/ScientificandAcademicResearch/s/article/KeyWords-Plus-generation-creation-and-changes?language=en_US

Clemons, R., & Slotnick, S. A. (2016) The effect of supply-chain disruption, quality and knowledge transfer on firm strategy. *International Journal of Production Economics*. 178169-186.

Cobo, M., López-Herrera, A., Herrera-Viedma, E., & Herrera, F. (2011) Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*. 62 (7), 1382–1402.

Colicchia, C. & Strozzi, F. (2012) Supply chain risk management: a new methodology for a systematic literature review. *Supply chain management.* 17 (4), 403–418.

DeCroix, G. A. (2013) Inventory management for an assembly system subject to supply disruptions. *Management Science*. *59* (9), 2079-2092.

Denyer, D., & Tranfield, D. (2009) Chapter 39 Producing a Systematic Review. In: Buchanan, D. and Bryman, A., Eds., The Sage Handbook of Organizational Research Methods, Editors Sage Publications Ltd., London, 671-689.

Ding, Y., Chowdhury, G. G., & Foo, S. (2001) Bibliometric cartography of information retrieval research by using co-word analysis. *Information processing & management*. 37 (6), 817-842.

Dolgui, A., Ivanov, D., & Sokolov, B. (2018) Ripple effect in the supply chain: an analysis and recent literature. *International Journal of Production Research*. 56 (1-2), 414-430.

Ellegaard, O. & Wallin, J. A. (2015) The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics.* 105 (3), 1809–1831.

Fagundes, M. V. C., Teles, E. O., Vieira de Melo, S. A. & Freires, F. G. M. (2020) Supply chain risk management modelling: A systematic literature network analysis review. *IMA Journal of Management Mathematics.* 31 (4), 387-416.

Fan, Y. & Stevenson, M. (2018) A review of supply chain risk management: definition, theory, and research agenda. International journal of physical distribution & logistics management. 48 (3), 205–230.

Fink, A. (2019) Conducting research literature reviews: From the internet to paper. Sage publications.

Forsman, M. (2016) Julkaisut ja tieteen mittaaminen: bibliometriikan käännekohtia. Tampere: Enostone.

Gao, L. (2015) Collaborative forecasting, inventory hedging and contract coordination in dynamic supply risk management. *European Journal of Operational Research*. 245 (1), 133-145.

Gao, S. Y., Simchi-Levi, D., Teo, C. P., & Yan, Z. (2019) Disruption risk mitigation in supply chains: the risk exposure index revisited. *Operations Research*. 67 (3), 831-852.

Glänzel, W. (1996) The need for standards in bibliometric research and technology. *Scientometrics*. 35 (2), 167-176.

Habermann, M., Blackhurst, J., & Metcalf, A. Y. (2015) Keep your friends close? Supply chain design and disruption risk. *Decision Sciences*. 46 (3), 491-526.

He, Q. (1999) Knowledge Discovery Through Co-Word Analysis. *Library trends*. 48 (1), 133–159.

Hood, W. W. & Wilson, C. S. (2001) The Literature of Bibliometrics, Scientometrics, and Informetrics. *Scientometrics.* 52 (2), 291–314.

Hossain, N. U. I., El Amrani, S., Jaradat, R., Marufuzzaman, M., Buchanan, R., Rinaudo, C., & Hamilton, M. (2020) Modeling and assessing interdependencies between critical infrastructures using Bayesian network: A case study of inland waterway port and surrounding supply chain network. *Reliability Engineering & System Safety*. *198*, 106898.

Hosseini, S., Ivanov, D., & Dolgui, A. (2020) Ripple effect modelling of supplier disruption: integrated Markov chain and dynamic Bayesian network approach. *International Journal of Production Research*. 58 (11), 3284-3303.

Hosseini, S., Morshedlou, N., Ivanov, D., Sarder, M. D., Barker, K., & Al Khaled, A. (2019) Resilient supplier selection and optimal order allocation under disruption risks. *International Journal of Production Economics*. 213124-137.

Ikea. (2021) Covid-19 -kriisin aiheuttamat tilapäiset saatavuus- ja toimitushaasteet. [www document]. [Accessed 19 February 2021]. Available: https://www.ikea.com/fi/fi/customer-service/covid-19-kriisin-aiheuttamat-tilapaeiset-saatavuus-ja-toimitushaasteet-pub053c304d

Ivanov, D. (2020) Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transportation Research Part E: Logistics and Transportation Review*. *136*, 101922.

Ivanov, D. (2018) Revealing interfaces of supply chain resilience and sustainability: a simulation study. *International Journal of Production Research*. 56 (10), 3507-3523.

Ivanov, D., & Sokolov, B. (2019) Simultaneous structural–operational control of supply chain dynamics and resilience. *Annals of Operations Research*. 283 (1), 1191-1210.

Ivanov, D., Pavlov, A., Dolgui, A., Pavlov, D., & Sokolov, B. (2016) Disruption-driven supply chain (re)-planning and performance impact assessment with consideration of pro-active and

recovery policies. *Transportation Research Part E: Logistics and Transportation Review*. 907-24.

Ivanov, D., Sokolov, B., Solovyeva, I., Dolgui, A., & Jie, F. (2016) Dynamic recovery policies for time-critical supply chains under conditions of ripple effect. *International Journal of Production Research*. 54 (23), 7245-7258.

Ji, X., Sun, J., & Wang, Z. (2017) Turn bad into good: Using transshipment-before-buyback for disruptions of stochastic demand. *International Journal of Production Economics*. 185150-161.

Kinra, A., Ivanov, D., Das, A., & Dolgui, A. (2020) Ripple effect quantification by supplier risk exposure assessment. *International Journal of Production Research*. 58 (18), 5559-5578.

Kitchenham, B. (2004) Procedures for performing systematic reviews. *Keele, UK, Keele University*. 33 (2004), 1-26.

Keele, S. (2007) *Guidelines for performing systematic literature reviews in software engineering* (Vol. 5). Technical report, Ver. 2.3 EBSE Technical Report. EBSE.

Kleindorfer, P. R. & Saad, G. H. (2005) Managing Disruption Risks in Supply Chains. *Production and operations management.* 14 (1), 53–68.

KTDRR. (2021a) Managing references. [www document]. [Accessed 7 March 2021]. Available https://ktdrr.org/resources/sr-resources/references.html

KTDRR. (2021b) Software Tools for Conducting Systematic Reviews. [www document]. [Accessed 7 March 2021]. Available https://ktdrr.org/resources/sr-resources/tools.html

Larson, P. D., & Rogers, D. S. (1998) Supply chain management: definition, growth and approaches. *Journal of Marketing Theory and Practice*. 6 (4), 1-5.

Lei, D., Li, J., & Liu, Z. (2012) Supply chain contracts under demand and cost disruptions with asymmetric information. *International journal of production economics*. 139 (1), 116-126.

Li, G., Fan, H., Lee, P. K., & Cheng, T. C. E. (2015) Joint supply chain risk management: An agency and collaboration perspective. *International Journal of Production Economics*. 164, 83-94.

Linnenluecke, M. K., Marrone, M., & Singh, A. K. (2020) Conducting systematic literature reviews and bibliometric analyses. *Australian Journal of Management*. 45 (2), 175-194.

Lohmer, J., Bugert, N., & Lasch, R. (2020) Analysis of resilience strategies and ripple effect in blockchain-coordinated supply chains: An agent-based simulation study. *International journal of production economics*. 228, 107882.

Macdonald, J. R. & Corsi, T. M. (2013) Supply Chain Disruption Management: Severe Events, Recovery, and Performance. *Journal of business logistics*. 34 (4), 270–288.

Macdonald, J. R., Zobel, C. W., Melnyk, S. A., & Griffis, S. E. (2018) Supply chain risk and resilience: theory building through structured experiments and simulation. *International Journal of Production Research*. 56 (12), 4337-4355.

Mallett, R., Hagen-Zanker, J., Slater, R., & Duvendack, M. (2012) The benefits and challenges of using systematic reviews in international development research. *Journal of development effectiveness*. 4 (3), 445-455.

Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado López-Cózar, E. (2018) Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics.* 12 (4), 1160–1177.

Mizgier, K. J., Wagner, S. M., & Jüttner, M. P. (2015) Disentangling diversification in supply chain networks. *International Journal of Production Economics*. 162, 115-124.

Munoz, A., & Dunbar, M. (2015) On the quantification of operational supply chain resilience. *International journal of production research*. 53 (22), 6736-6751.

Nair, A., & Vidal, J. M. (2011) Supply network topology and robustness against disruptions–an investigation using multi-agent model. *International Journal of Production Research*. 49 (5), 1391-1404.

Nooraie, S. V., & Parast, M. M. (2016) Mitigating supply chain disruptions through the assessment of trade-offs among risks, costs and investments in capabilities. *International Journal of Production Economics*. 171, 8-21.

Noyons, E., Moed, H., & Van Raan, A. (1999) Integrating research performance analysis and science mapping. *Scientometrics.* 46 (3), 591-604.

Paul, S. K., Asian, S., Goh, M., & Torabi, S. A. (2019) Managing sudden transportation disruptions in supply chains under delivery delay and quantity loss. *Annals of Operations Research*. 273 (1-2), 783-814.

Paul, S. K., & Rahman, S. (2018) A quantitative and simulation model for managing sudden supply delay with fuzzy demand and safety stock. *International Journal of Production Research*. 56 (13), 4377-4395.

Paul, S. K., Sarker, R., & Essam, D. (2015) A disruption recovery plan in a three-stage production-inventory system. *Computers & Operations Research*. 57, 60-72.

Parast, M. M. (2020) The impact of R&D investment on mitigating supply chain disruptions: empirical evidence from US firms. *International Journal of Production Economics*. *227*, 107671.

Pavlov, A., Ivanov, D., Dolgui, A., & Sokolov, B. (2018) Hybrid fuzzy-probabilistic approach to supply chain resilience assessment. *IEEE Transactions on Engineering Management*. 65 (2), 303-315.

Peng, M., Peng, Y., & Chen, H. (2014) Post-seismic supply chain risk management: A system dynamics disruption analysis approach for inventory and logistics planning. *Computers & Operations Research*. 42, 14-24.

Persson, O., Danell, R., & Schneider, J. W. (2009) How to use Bibexcel for various types of bibliometric analysis. Celebrating scholarly communication studies: A Festschrift for Olle Persson at his 60th Birthday. (5) 9-24.

Petticrew, M., & Roberts, H. (2008) *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons.

Pournader, M., Kach, A. & Talluri, S. (2020) A Review of the Existing and Emerging Topics in the Supply Chain Risk Management Literature. *Decision sciences*. 51 (4), 867–919.

Pulsiri, N., & Vatananan-Thesenvitz, R. (2018) Improving systematic literature review with automation and bibliometrics. In *2018 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1-8). IEEE.

Ribeiro, J. P., & Barbosa-Povoa, A. (2018) Supply Chain Resilience: Definitions and quantitative modelling approaches–A literature review. *Computers & Industrial Engineering*. 115, 109-122.

Sabouhi, F., Jabalameli, M. S., Jabbarzadeh, A., & Fahimnia, B. (2020) A multi-cut L-shaped method for resilient and responsive supply chain network design. *International Journal of Production Research*. 58 (24), 7353-7381.

Salminen, A. (2011) Mikä kirjallisuuskatsaus? Johdatus kirjallisuuskatsauksen tyyppeihin ja hallintotieteellisiin sovelluksiin. Vaasa: Vaasan yliopisto.

Sawik, T. (2016) On the risk-averse optimization of service level in a supply chain under disruption risks. *International Journal of Production Research*. 54 (1), 98-113.

Shekarian, M., Nooraie, S. V. R., & Parast, M. M. (2020) An examination of the impact of flexibility and agility on mitigating supply chain disruptions. *International Journal of Production Economics*. 220, 107438.

Sokolov, B., Ivanov, D., Dolgui, A., & Pavlov, A. (2016) Structural quantification of the ripple effect in the supply chain. *International Journal of Production Research*. 54 (1), 152-169.

Tan, W. J., Cai, W., & Zhang, A. N. (2020) Structural-aware simulation analysis of supply chain resilience. *International Journal of Production Research*. 58 (17), 5175-5195.

Tang, C. S. (2006) Perspectives in supply chain risk management. *International journal of production economics*. 103 (2), 451–488.

Tieteen Kuvalehti. (2018) Tuhkapilvi pysäytti lentoliikenteen. [www document]. [Accessed 11 March 2021]. Available: https://tieku.fi/luonto/tulivuoret/tuhkapilvi-pysaytti-lentoliikenteen

Tranfield, D., Denyer, D., & Smart, P. (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*. 14 (3), 207-222.

Van Eck, N. J., & Waltman, L. (2014) Visualizing bibliometric networks. In *Measuring scholarly impact* (pp. 285-320). Springer, Cham.

Verbeek, A., Debackere, K., Luwel, M., & Zimmermann, E. (2002) Measuring progress and evolution in science and technology – I: The multiple uses of bibliometric indicators. *International journal of management reviews: IJMR.* 4 (2), 179–211.

Vogel, R. & Güttel, W. H. (2013) The Dynamic Capability View in Strategic Management: A Bibliometric Review. *International journal of management reviews: IJMR*. 15 (4), 426–446.

Wang, G., Huang, S. H., & Dismukes, J. P. (2005) Manufacturing supply chain design and evaluation. *The International Journal of Advanced Manufacturing Technology*. 25 (1-2), 93-100.

Wallin, J. A. (2005) Bibliometric Methods: Pitfalls and Possibilities. *Basic & clinical pharmacology & toxicology.* 97 (5), 261–275.

Wong, C. W., Lirn, T. C., Yang, C. C., & Shang, K. C. (2020) Supply chain and external conditions under which supply chain resilience pays: An organizational information processing theorization. *International Journal of Production Economics*. 226, 107610.

Yang, T., & Fan, W. (2016) Information management strategies and supply chain performance under demand disruptions. *International Journal of Production Research*. 54 (1), 8-27.

Zhao, K., Scheibe, K., Blackhurst, J., & Kumar, A. (2018) Supply chain network robustness against disruptions: topological analysis, measurement, and optimization. *IEEE Transactions on Engineering Management*. 66 (1), 127-139.

Zupic, I. & Cater, T. (2015) Bibliometric methods in management and organization. *Organizational Research Methods.* 18 (3), 429–472.

Appendices

Appendix 1. Sample's articles.

Title	Year	Authors	Source Title
Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case	2020	Ivanov, Dmitry	*Transportation Research Part E: Logistics and Transportation Review*
Ripple effect modelling of supplier disruption: integrated Markov chain and dynamic Bayesian network approach	2020	Hosseini, Seyedmohsen; Ivanov, Dmitry & Dolgui, Alexandre	*International Journal of Production Research*
Analysis of resilience strategies and ripple effect in blockchain-coordinated supply chains: An agent-based simulation study	2020	Lohmer, Jacob; Bugert, Niels & Lasch, Rainer	*International Journal of Production Economics*
Ripple effect quantification by supplier risk exposure assessment	2020	Kinra, Aseem; Ivanov, Dmitry; Das, Ajay & Dolgui, Alexandre	*International Journal of Production Research*
An examination of the impact of flexibility and agility on mitigating supply chain disruptions	2020	Shekarian, Mansoor; Nooraie, Seyed Vahid Reza & Parast, Mahour Mellast	*International Journal of Production Economics*
Modeling and assessing interdependencies between critical infrastructures using Bayesian network: A case study of inland waterway port and surrounding supply chain network	2020	Hossain, Niamat Ullah Ibne; El Amrani, Safae; Jaradat, Raed; Marufuzzaman, Mohammad; Buchanan, Randy; Rinaudo, Christina & Hamilton, Michael	*Reliability Engineering & System Safety*
Supply Chain Disruptions and Business Continuity: An Empirical Assessment	2020	Azadegan, Arash; Mellat Parast, Mahour; Lucianetti, Lorenzo; Nishant, Rohit & Blackhurst, Jennifer	*Decision Sciences*
Supply chain and external conditions under which supply chain resilience pays: An organizational information processing theorization	2020	Wong, Christina W. Y.; Lirn, Taih-Cherng; Yang, Ching-Chiao & Shang, Kuo-Chung	*International Journal of Production Economics*
The impact of R&D investment on mitigating supply chain disruptions: Empirical evidence from US firms	2020	Parast, Mahour Mellat	*International Journal of Production Economics*
Stock Market Reaction to Supply Chain Disruptions from the 2011 Great East Japan Earthquake	2020	Hendricks, Kevin; Jacobs, Brian & Singhal, Vinod	*Manufacturing & Service Operations Management*
Structural-aware simulation analysis of supply chain resilience	2020	Tan, Wen Jun; Cai, Wentong & Zhang, Allan	*International Journal of Production Research*
Supply chain involvement in business continuity management: effects on reputational and operational damage containment from supply chain disruptions	2020	Azadegan, Arash; Syed, Tahir Abbas; Blome, Constantin & Tajeddini, Kayhan	*Supply Chain Management: An International Journal*
Operational resilience, disruption, and efficiency: Conceptual and empirical analyses	2020	Essuman, Dominic; Boso, Nathaniel & Annan, Jonathan	*International Journal of Production Economics*
A multi-cut L-shaped method for resilient and responsive supply chain network design	2020	Sabouhi, Fatemeh; Jabalameli, Mohammad Saeed; Jabbarzadeh, Armin & Fahimnia, Behnam	*International Journal of Production Research*

Resilient supplier selection and optimal order allocation under disruption risks	2019	Hosseini, Seyedmohsen; Morshedlou, Nazanin; Ivanov, Dmitry; Sarder, M. D.; Barker, Kash & Al Khaled, Abdullah	*International Journal of Production Economics*
A perishable product supply chain network design problem with reliability and disruption considerations	2019	Diabat, Ali; Jabbarzadeh, Armin & Khosrojerdi, Amir	*International Journal of Production Economics*
Managing sudden transportation disruptions in supply chains under delivery delay and quantity loss	2019	Paul, Sanjoy Kumar; Asian, Sobhan; Goh, Mark & Torabi, S. Ali	*Annals of Operations Research*
Simultaneous structural-operational control of supply chain dynamics and resilience	2019	Ivanov, Dmitry & Sokolov, Boris	*Annals of Operations Research*
Disruption Risk Mitigation in Supply Chains: The Risk Exposure Index Revisited	2019	Gao, Sarah Yini; Simchi-Levi, David; Teo, Chung-Piaw & Yan, Zhenzhen	*Operations Research*
Supply Chain Network Robustness Against Disruptions: Topological Analysis, Measurement, and Optimization	2019	Zhao, Kang; Scheibe, Kevin; Blackhurst, Jennifer & Kumar, Akhil	*IEEE Transactions on Engineering Management*
A mathematical modelling approach for managing sudden disturbances in a three-tier manufacturing supply chain	2019	Paul, Sanjoy Kumar; Sarker, Ruhul; Essam, Daryl & Lee, Paul Tae-Woo	*Annals of Operations Research*
The impact of corporate distress along the supply chain: evidences from United States	2019	Gibilaro, Lucia & Mattarocci, Gianluca	*Supply Chain Management: An International Journal*
Ripple effect in the supply chain: an analysis and recent literature	2018	Dolgui, Alexandre; Ivanov, Dmitry & Sokolov, Boris	*International Journal of Production Research*
Bayesian network modelling for supply chain risk propagation	2018	Ojha, Ritesh; Ghadge, Abhijeet; Tiwari, Manoj Kumar & Bititci, Umit	*International Journal of Production Research*
Supply chain risk and resilience: theory building through structured experiments and simulation	2018	Macdonald, John; Zobel, Christopher; Melnyk, Steven & Griffis, Stanley	*International Journal of Production Research*
Hybrid Fuzzy-Probabilistic Approach to Supply Chain Resilience Assessment	2018	Pavlov, Alexander; Ivanov, Dmitry; Dolgui, Alexandre & Sokolov, Boris	*IEEE Transactions on Engineering Management*
Real options approach to evaluate postponement as supply chain disruptions mitigation strategy	2018	Carbonara, Nunzia & Pellegrino, Roberta	*International Journal of Production Research*
A quantitative and simulation model for managing sudden supply delay with fuzzy demand and safety stock	2018	Paul, Sanjoy Kumar & Rahman, Shams	*International Journal of Production Research*
Strategic Behavior of Suppliers in the Face of Production Disruptions	2018	Demirel, Suleyman; Kapuscinski, Roman & Yu, Man	*Management Science*
Liquefied natural gas inventory routing problem under uncertain weather conditions	2018	Cho, Jaeyoung; Lim, Gino J.; Kim, Seon Jin & Biobaku, Taofeek	*International Journal of Production Economics*
A framework for designing supply chain disruptions management considering productive systems and carrier viewpoints	2018	Blos, Mauricio Fontoura; da Silva, Robson Marinho & Wee, Hui-Ming	*International Journal of Production Research*
Stages of Supply Chain Disruption Response: Direct, Constraining, and Mediating Factors for Impact Mitigation	2017	Bode, Christoph & Macdonald, John R.	*Decision Sciences*

Effectiveness of resilience capabilities in mitigating disruptions: leveraging on supply chain structural complexity	2017	Birkie, Seyoum Eshetu; Trucco, Paolo & Campos, Pablo Fernandez	*Supply Chain Management: An International Journal*
The effect of slack, diversification, and time to recall on stock market reaction to toy recalls	2017	Wood, Lincoln C.; Wang, Jason X.; Olesen, Karin & Reiners, Torsten	*International Journal of Production Economics*
Turn bad into good: Using transshipment-before-buy-back for disruptions of stochastic demand	2017	Ji, Xiang; Sun, Jiasen & Wang, Zebin	*International Journal of Production Economics*
Disruption-driven supply chain (re)-planning and performance impact assessment with consideration of pro-active and recovery policies	2016	Ivanov, Dmitry; Pavlov, Alexander; Dolgui, Alexandre; Pavlov, Dmitry & Sokolov, Boris	*Transportation Research Part E: Logistics and Transportation Review*
Structural quantification of the ripple effect in the supply chain	2016	Sokolov, Boris; Ivanov, Dmitry; Dolgui, Alexandre & Pavlov, Alexander	*International Journal of Production Research*
On the risk-averse optimization of service level in a supply chain under disruption risks	2016	Sawik, Tadeusz	*International Journal of Production Research*
Dynamic recovery policies for time-critical supply chains under conditions of ripple effect	2016	Ivanov, Dmitry; Sokolov, Boris; Solovyeva, Inna; Dolgui, Alexandre & Jie, Ferry	*International Journal of Production Research*
Mitigating supply chain disruptions through the assessment of trade-offs among risks, costs and investments in capabilities	2016	Nooraie, Valid & Parast, Mahour Mellat	*International Journal of Production Economics*
Information management strategies and supply chain performance under demand disruptions	2016	Yang, Tianjian & Fan, Weiguo	*International Journal of Production Research*
The effect of supply-chain disruption, quality and knowledge transfer on firm strategy	2016	Clemons, Rebecca & Slotnick, Susan	*International Journal of Production Economics*
Examining the influence of supply chain glitches on shareholder wealth: does the reason matter?	2016	Zsidisin, George; Petkova, Boyana & Dam, Lammertjan	*International Journal of Production Research*
On the quantification of operational supply chain resilience	2015	Munoz, Albert & Dunbar, Michelle	*International Journal of Production Research*
Keep Your Friends Close? Supply Chain Design and Disruption Risk	2015	Habermann, Marco; Blackhurst, Jennifer & Metcalf, Ashley	*Decision Sciences*
A behavioral experiment on inventory management with supply chain disruption	2015	Sarkar, Sourish & Kumar, Sanjay	*International Journal of Production Economics*
Disentangling diversification in supply chain networks	2015	Mizgier, Kamil; Wagner, Stephan & Juettner, Matthias	*International Journal of Production Economics*
The impact of supply base complexity on disruptions and performance: the moderating effects of slack and visibility	2015	Brandon-Jones, Emma; Squire, Brian & Van Rossenberg, Yvonne	*International Journal of Production Research*
Robust supply chain strategies for recovering from unanticipated disasters	2015	Chen, Li-Ming; Liu, Yan Emma; Yang & Shu-Jung Sunny	*Transportation Research Part E: Logistics and Transportation Review*
Collaborative forecasting, inventory hedging and contract coordination in dynamic supply risk management	2015	Gao, Long	*European Journal of Operational Research*

A disruption recovery plan in a three-stage production-inventory system	2015	Paul, Sanjoy Kumar; Sarker & Ruhul; Essam, Daryl	*Computers & Operations Research*
Coordinating a supply chain under demand and cost disruptions	2015	Cao, Erbao; Zhou, Xiushuai & Lu, Kevin	*International Journal of Production Research*
Post-seismic supply chain risk management: A system dynamics disruption analysis approach for inventory and logistics planning	2014	Peng, Min; Peng, Yi & Chen, Hong	*Computers & Operations Research*
Dynamic impact on global supply chains performance of disruptions propagation produced by terrorist acts	2014	Bueno-Solano, Alfredo & Gaston Cedillo-Campos, Miguel	*Transportation Research Part E: Logistics and Transportation Review*
Looking Inside Glitch Mitigation Capability: The Effect of Intraorganizational Communication Channels	2014	Tenhiaelae, Antti & Salvador, Fabrizio	*Decision Sciences*
Does firm innovativeness enable effective responses to supply chain disruptions? An empirical study	2013	Golgeci, Ismail & Ponomarov, Serhiy	*Supply Chain Management: An International Journal*
Supply Chain Risk Management: An Agent-Based Simulation to Study the Impact of Retail Stockouts	2013	Wu, Teresa; Huang, Simin; Blackhurst, Jennifer; Zhang, Xiaoling & Wang, Shanshan	*IEEE Transactions on Engineering Management*
Inventory Management for an Assembly System Subject to Supply Disruptions	2013	DeCroix, Gregory	*Management Science*
Supply chain contracts under demand and cost disruptions with asymmetric information	2012	Lei, Dong; Li, Jianbin & Liu, Zhixue	*International Journal of Production Economics*
The impact of collaborative transportation management on demand disruption of manufacturing supply chains	2012	Li, Jing & Chan, Felix T. S.	*International Journal of Production Research*
Supply network topology and robustness against disruptions - an investigation using multi-agent model	2011	Nair, Anand & Vidal, Jose M.	*International Journal of Production Research*
A single-period analysis of a two-echelon inventory system with dependent supply uncertainty	2011	Masih-Tehrani, Behdad; Xu, Susan H.; Kumara, Soundar & Li, Haijun	*Transportation Research Part B: Methodological*