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Supply Chain Risk Assessment: Literature Review and Network Analysis

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Abstract

This paper discusses the various works and researches in Supply Chain Risk Assessment SCRA. The methodology chosen is the systematic literature review and the network analysis in order to collect and analysis methods and tendences of supply chain risk assessment in the period between 2019 and 2022. To this end, the study detected four methods extracted from 72 article, which are: Analytic Hierarchy Process (AHP), Failure Mode and Effect Analysis (FMEA), Decision Making Trial and Evaluation Laboratory (DEMATEL) and House of risks method HOR. This study analyses also the bibliometric data and the visualization of similarities (VOS) viewer method to graphically map that data collected from the Web of Science database. The graphical analysis uses citation, co-citation, and co-occurrence analysis. All these results provide a strong starting point for operations researches in this domain for future works.

Keywords
Supply Chain Management, Risk Assessment, Literature review, Network analysis.

1. Introduction

The 2019 coronavirus pandemic, commonly known as COVID-19, has impacted people all across the world and brought about a number of changes. The economic sectors including manufacturing industries and their supply chains have also been touched. The impacts of COVID-19 have been far-reaching and, according to some analysts, they will not disappear before the end of 2022. So, the escalating COVID-19 pandemic has heightened global concerns regarding the consequences for and restoration of international supply chains. Before this crisis, risk management was used to identify and minimize risks that may affect the supply chain's efficiency. The 2008 recession, SARS, the Indonesian Tsunami, and the Swine Flu, for example, were all low-probability occurrences risks that had a substantial influence on supply chains between 2000 and 2010.

So nowadays, a risk cannot be neglected especially supply chain risks. In such a highly uncertain business environment, practitioners and researchers have put a higher level of attention to supply chain risk management(BCI, n.d.). Companies can proactively manage uncertainties that may occur in the future by defining and assessing risks. And the management of supply chain risks has emerged as an important area of research in the field of supply chain management. But, according to the 'Global Risk Report 2020', Supply Chain Risk Management SCRM present a significant challenge because of the interconnection between risks and how this may lead to system complexity(World Economic Forum 2020). For this aim, the rapid rise and frequency of global risks has pushed academics and researchers to become interested in this topic, thus generating a large amount of literature. The definition provided by Ho et al. (Ho et al. 2015) present four stages in SCRM: Risk identification, Risk assessment, Risk mitigation, and Risk

recovery or resilience. And as result of its research, Alina Díaz Curbelo (Díaz Curbelo et al. 2018) has proved that the risk assessment stage has received the most attention and a significant number of works in both academia and professional areas. In continuity of the previous works, this article aims to present a review of literature of the SCRA methods and a network analysis in the 2019-2022 period, and this by responding to the research questions presented below:

What are the most used and developed methodologies for risk assessment, and what are their benefits and drawbacks?

What is the current state-of-the-art in SCRA after the Covid-19 pandemic?

1.1 Objectives

The objective of the current study is to take a holistic strategy. (i.e., a systematic review and a combination of and network analyses) for generating in-depth discussions of the relevant issues in the top operations and supply chain management journals through a highlight of SCRA methods and technics, their advantages, limits, and suggestions for future researches. And in the second part, a network analysis of the pool of publications we obtain from Web of science published in 2019-2022 period, but it's not exhaustive.

2. Methods

A literature review is "an essential component of almost any research project. It serves as the foundation for advancing knowledge, facilitates theory development, closes mature research areas, and uncovers novel research areas"**(Jane W**ebster and Richard T. Watson 2002**)** Structured literature reviews are typically completed through an iterative cycle of defining appropriate search keywords, searching the literature, and completing the analysis (Mark N.K. Saunders, Philip Lewis and Adrian Thornhill, 2019**)** So in our approach, we use a five-step methodology, as illustrated in Figure 2, for data collecting and comprehensive field evaluation.

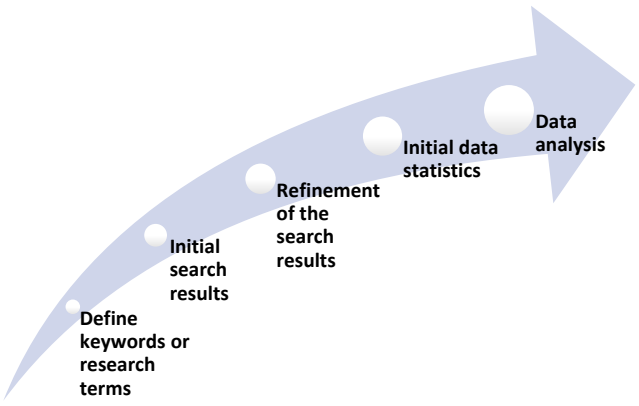

Figure 1. Research methodology

Step 1: Defining Keywords and Timeframe

The keywords used for data collection include two levels, conjunctively combined with AND. The first level defines the context of this search: "Supply Chain", and the second level is the risk management especially "Risk assessment". These two levels of keywords were selected due to our intention to gather comprehensive data from two sub-outlets, namely supply chain management and risk management.

To ensure the timeline's recency and applicability, we focused on the literature since 2019 to 2022. Additionally, this time frame was chosen because it coincides with the COVID-19 pandemic, which has forced supply chain management practitioners and researchers to start questioning and thinking deeply assumptions about the field.

Step 2: Initial search results

Using the "title, abstract, keywords" search in Web of science and Scopus databases, we collected and stored "journal" articles for the defined search terms, and we choose 'supply chain and logistics' for citation topics. The initial search

attempts resulted in a total of 295 articles (106 in Web of science and 189 in Scopus). Information from the search results, which included the paper title, authors' names and affiliations, abstract, keywords, and references, was saved in Excel format.

Step 3: Refinement of the search results
Using Microsoft Excel, we further filtered the results to find the publications that specifically address SCRA by verifying that the titles had one or more of the words "assess," "identify," or "analyze" and we then examining the abstracts of these papers carefully to make sure the article was indeed about SCRA. And by eliminating duplications, only 72 papers were selected.

Step 4: Initial data statistics
The Figure 1 shows the evolution of the number of papers published. As can be seen in the previous graph, the number of publications increased from 2019 until 2022. With our search concluding, the already number of publications on the topic indicates increasing interest especially after the period of the pandemic. The initial statistics of article's sources shown that 51 journals have contributed to the publication of articles in our sample. It was found that 3 journals present 41% of all papers published and Table1 reports them according to the number of papers published and year of publication. And clearly, journal of sustainability is the relevant one with 27% of papers published.

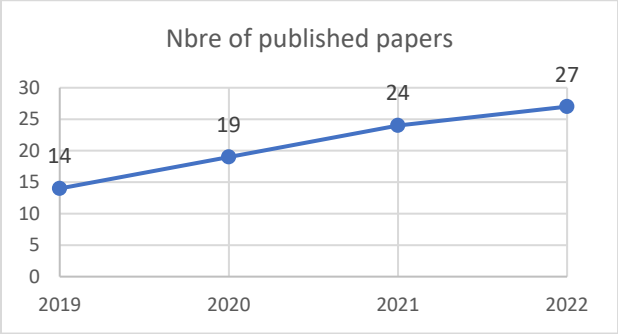

Figure 2. Published trend in SCR

Step 5: Data analysis
In this step, we will present the most used methods for the assessment of supply chain risk from our sample.

Table 1. Top 5 journals contributing to the SCRA topic

Journal	**Publication year**			
	2019	**2020**	**2021**	**2022**
Computer & industrial engineering	1	1	1	1
Discrete Dynamics in Nature and Society	-	-	2	1
Sustainability	-	2	9	3
Total	1	3	12	5

3. Results

3.1 Description and analysis of commonly used methods/tools for supply chain Risk assessment

In the past decade, several risk assessment methods have been developed, especially for assessing supply chain-related risks. There are three types of methods used for determining the level of risk in the risk assessment step: Qualitative methods, Quantitative methods, and Semi-quantitative methods.

-"Qualitative analysis uses words to describe the magnitude of potential severity and the likelihood that those severity will occur, so this method uses expert knowledge and experience to determine likelihood and severity category"**(Devdatt P Purohit*, Dr.N A Siddiqui, Abhishek Nandan & Dr.Bikarama P Yadav, 2018)**

-"Quantitative analysis uses numerical values (rather than the descriptive scales used in qualitative and semi-quantitative analysis) for both severity and likelihood using data from a variety of sources such as past accident experience and from scientific research"**(Devdatt P Purohit*, Dr.N A Siddiqui, Abhishek Nandan & Dr.Bikarama P Yadav, 2018)**.

In this section, we will proceed with a review of the SCRA technics and methods presented in the articles selected previously. Figure 4 present technics and methods applied, their frequency in the articles selected.

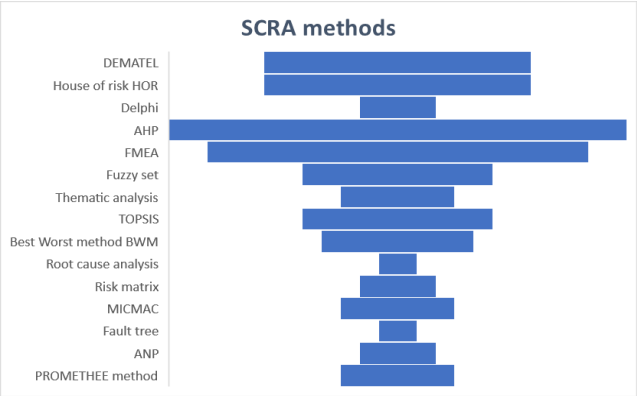

Figure 3. Distribution of SCRA methods

As presented in the figure 11, the most used methods for the assessment and evaluation of SCR are: Analytic Hierarchy Process (AHP) with 18%, Failure Mode and Effect Analysis (FMEA) with 15%, Decision Making Trial and Evaluation Laboratory (DEMATEL) with 10% and House of risks method HOR with 12%.

- Analytic Hierarchy Process (AHP):

The Analytic Hierarchy Process (AHP) is "a method based on the conversion of qualitative expressions into quantitative results as a result of many steps and is a method that is frequently used in the literature"(Oturakçı & Yıldırım, 2022). In fact, the hierarchical structure of AHP methodology "is able to measure and synthetize a variety of factors of a complex decision making process in a hierarchical manner, making it simple to combine the parts in a whole"(Russo & Camanho, 2015a). To use the AHP method, two ways to evaluate the alternatives were observed by Russo and Camanho (2015): "rating, also called absolute judgment, for the analysis of quantitative criteria and pairwise or relative judgment, for the analysis of qualitative criteria"(Russo & Camanho,2015b).

According to Emrouznejad and Marra (2017) "the main advantages of the most advanced conceptualizations of AHP are that it allows hierarchical modelling of the problem, and the possibility to make verbal judgements and to confirm consistency"(Emrouznejad & Marra 2017). Among the articles selected, Murat OTURAKÇ and Rabia Sultan YILDIRIM aimed to use this fuzzy technic combined with TOPSIS to define, decide, and prioritize the supply chain risk factors in businesses. So, according to them, the reason for choosing Fuzzy AHP in their study is to improve linguistic ambiguity in binary comparison assessments and raise objectivity of decision-makers. In another example of its application, Dias; et al.(2021)(Dias et al. 2021) selected AHP tool for the assessment of risks of the import and export process of an automotive industry located in Brazil. And related to them, this method was chosen because of its biggest advantages in the analysis of possible inconsistencies in the responses of the specialists, through a "disturbance matrix", developed for this purpose. As the AHP method can be also combined with other risk assessment

methods to making decisions under a deterministic condition, Chai and Zhou (2022) proposed "a novel hybrid five-phase fuzzy MCDM approach by integrating interval valued triangle fuzzy numbers (IVTFNs), IVTFN-AHP, IVTFN-TOPSIS, and cumulative prospect theory in their study"(Chai & Zhou 2022). After its application, its proved that the hybrid five-phase decision-making approach proposed is feasible and reliable.

Table 2. Analysis of AHP method

Analytic Hierarchy Process (AHP)			
Type	**Citations**	**Limitations**	**Recommendations**
Quantitative	(Dias et al., 2021); (Oturakçı & Yıldırım, 2022); (Das et al., 2022); (Kabak & Öztek, 2022); (Chai & Zhou, 2022); (Md Hanafiah et al., 2022); (Gao et al., 2021); (Essaber et al., 2021a); (Yan et al., 2020); (Sales et al., 2020); (Kurniawan et al., 2019a); (Abdel-Basset et al., 2019);	-Very complex process. -The large amount of pairwise comparisons to conduct. -The problem of designing consistent hierarchies. -The issue of aggregating opinions of different peers.	-The integration of AHP with other methods (combined AHP and QFD to overcome he potential arbitrary judgement of the decision-maker, methods such as TOPSIS and mathematical programming can compensate for the AHP by considering not only qualitative and quantitative factors, but also information about real-world resources limitations, the integration of DEA with AHP to generate local weights of alternatives from pairwise comparison judgement matrix(Emrouznejad & Marra, 2017))

- Failure Mode and Effect Analysis (FMEA):
The FMEA method is also known as: FMECA (Failure Mode and Criticality Analysis) and AMDEC (Analyse des Modes de Defaillace et Leurs Effets). It's "a popular approach to analyze risks and one of the widely used risk assessment tools in the literature that considers probability, noticeability and severity criteria to identify existing and potential failures in a system"(Schneider, H., 1996). In traditional FMEA, "the rank of failure modes usually depends on the value of the risk priority number (RPN), which can be obtained by RPN = S × O × D, where S denotes the severity of the effect of the failure, O denotes the occurrence probability of the failure, and D denotes the detectability of the failure before its influence occurred"(Zhou et al., 2021). Contrary to the AHP method, the FMEA has a clear structure that makes it simple to comprehend and use. Many research that used FMEA as the risk analysis technique has demonstrate its successful implementation. An example is presented by Mandavi Sahu and Dr Sapna Arora. Those two researchers had to identify pulse processing firms' risk factors and measure the severity of these risks. In this study, the FMEA and Pareto Analysis are applied to identify the potential risk and determine their severity index with the help of the Pareto analysis chart, and the ANOVA method is then used to generate the frequency of F- the value of risk factors impact on pulse firms to understand the level of significance of risk factors.

We also found the research of Bakos, L. and Dumitrașcu, D.D in which they had studied risk management techniques under rapidly changing environments in highly standardized industries (pharmaceutical and automotive). For this aim they had chosen three common risk assessment tools: Risk management based on standards, the PDCA (Plan-Do-Check-Act) cycle and FMEA (Failure Mode and Effects Analysis). According to their findings, "the risk evaluation is more a document-based activity (indicating a kind of "surface" compliance to the standards), and less a brainstorming-like creativity-based activity. There is mostly a systematic application of enterprise policies, in many cases expert judgment is the single source for risk data. Risk assessment and mitigation techniques should go beyond the rigid "cause-and-effect"- or "if-and-then"- based approach"(Bakos & Dumitrașcu 2021).

Table 3. Analysis of FMEA method

Failure Mode and Effect Analysis (FMEA)			
Type	Citations	Limitations	Recommendations
Qualitative	(Hernadewita & Saleh, 2020); (Gui et al., 2022); (Wu et al., 2019); (Mustaniroh et al., 2020); (Shojaeimehr & Rahmani, 2022); (Le Tohic et al., 2022); (Mandavi Sahu & Dr Sapna Arora, 2022); (Bakos & Dumitrașcu, 2021); (Kurniawan et al., 2019b); (Tanjung, Atikah, et al., 2019)	-The use of FMEA may be difficult for the case of complex systems. -The approach has problems with imprecise data. -The RPN value is rarely provided with precision by experts in the field for risk evaluation in the real world. -Knowledge from domain experts are crucial to the FMEA risk evaluation process.	-Professional and academic literature highlighted several complementary and auxiliary tools, such as boundary diagrams, p-diagram, interfacing diagram, FTA, brainstorming for FMEA analysis. These tools allow a better understanding of the system and are used to ensure a robust analysis of the system(Benjamin Cabanes, Stéphane Hubac, Pascal Le Masson, Benoit Weil, 2021). -The recent AIAG and VDA handbook (2019) proposes a new approach for FMEA development: the 7-step approach and this new procedure includes more emphasis on the system analysis(Benjamin Cabanes, Stéphane Hubac, Pascal Le Masson, Benoit Weil, 2021).

- Decision Making Trial and Evaluation Laboratory (DEMATEL):

DEMATEL (The Decision-Making Trial and Evaluation Laboratory), one of the MCDM methods, "was developed in 1972 by the Battelle Memorial Institute of Geneva Research Center. The method is used in solving complex problem groups"(Bilecik Seyh Edebali University, Department of Business Administration, Bilecik, Turkey et al., 2021). The DEMATEL method, "which assumes that all criteria determined for the decision-making problem are in interaction with each other, evaluates the effect levels among the criteria. In the method, factors that are higher than the other criteria are called distributive, and criteria whose exposure level is higher than the effect on the system are called buyers"(Serhat KARAOĞLAN, 2016). In the study of Üstündağ A.; et al. supply chain risks in the iron and steel industry are assed using the DEMATEL method for the only reason that there is no study using this method to assess supply chain risks in the steel industry. In another context, Shafiee; et al. had analyzed interrelations among risks that arise from the COVID-19 outbreak to provide practical insights for decision-makers. For this aim, after identifying risks, the decision-making trial and evaluation laboratory (DEMATEL) method is used to evaluate the interrelationships among risks to perishable product supply chain networks during the COVID-19 outbreak for its advantages such as "its ability to generate the effect relation map of factors, which provides the opportunity to perform a causal analysis among various factors"(Kou, G., Akdeniz, Ö.O., Dinçer, H., Yüksel, S. 2021). Also, "it accepts all

transferable relations and can sight every possible feedback, which is another superiority of the DEMATEL method compared to others"(Mostafaeipour, A., Qolipour, M., Goudarzi, H., 2019). However, "the conventional DEMATEL method has some limitations regarding the subjectivity and impreciseness of experts' inputs"(Khan et al. 2020).

Table 4. Analysis of DEMATEL method

Decision Making Trial and Evaluation Laboratory (DEMATEL)			
Type	**Citations**	**Limitations**	**Recommendations**
Hybrid (combines both qualitative and quantitative elements)	(Üstündağ et al., 2022); (Shafiee et al., 2022); (Gultekin et al., 2022); (Das et al., 2022); (U-Dominic et al., 2021); (Shafiee et al., 2022);	-It requires expert's opinions. -Results could be complex and difficult to interpret. -It analyses a limited number of factors or criteria. -Does not account for external factors.	-Promote the use of sophisticated data collection tools (online surveys, interview protocols…) -Include more analytical methods or instruments to consider external factors such as: SWOT or PESTEL analysis. -Integrate DEMATEL with other analytical methods like cost-benefit analysis or multi-criteria decision analysis methods.

- House of risks method HOR:

The house of risk is "a proactive model which is used to identify potential risk events, assess the probability of occurrence of risk agents, and analyze the relationship of each risk event and agent in the supply chains"(Boonyanusith & Jittamai, 2018). It's "a useful risk management tool which can be applied in practice with the calculation using a simple spreadsheet application. Several analytical methods can be integrated into the HOR model for making the identification of risk events and associated risk agents as well as the evaluation of proactive actions more quantifiable"(Boonyanusith & Jittamai, 2018). HOR "is a modification between FMEA (Failure Mode and Effect Analysis) and HOQ (House of Quality) models and consists of two phases: HOR1 is used to determining the process and agents causing the risk and HOR2 is used to determine which actions are to be done first, considering their differing effectiveness as well as resources involved and the degree of difficulties in performing"(Ratnasari et al., 2018). As one of the uncertainty measurement analysis methods in the supply chain, HOR was developed by Pujawan, and Geraldin(Nyoman Pujawan & Geraldin 2009) then used for the assessment of risks by many practitioners and researchers. : A Nalhadi et al are one of them and they had chosen the HOR to determine the probability level of the risk agent and severity associated with the risk event in the supply chain of the production of Katon shirts. Amrina and Wardah had identified and investigate the potential risks amongst the supply chain actors of hybrid corn by applying the House of risk method to determine the severity of risk events and the occurrence of risk agents. While it's a helpful tool in SCRM, its use has several restrictions and disadvantages such as its subjectivity, so as a result, risk evaluation may become biased and inconsistent. It might not fully cover complicated hazards or dangers with many causes.

Table 5. Analysis of HOR methods

Decision Making Trial and Evaluation Laboratory (DEMATEL)			
Type	Citations	Limitations	Recommendations
Qualitative	(Nalhadi et al., 2019a); (Amrina & Wardah, 2019);	-Results may be influenced by the individual perspective (subjectivity).	-Standardization of the HOR method. -Incorporate stakeholders in the process of risk assessment and management.

	(Paillin & Tupan, 2021); (Wahyuni et al., 2020); (Citraresmi & Rahmawati, 2020); (Nalhadi et al., 2019b); (Parenreng et al., 2019); (Tanjung, Khodijah, et al., 2019)	-It could not be suitable for complex systems. -It relies on qualitative assessment so the result could be imprecise. -The visual representation of risks could be difficult to communicate.	-Incorporate emerging risks or new technologies into the risk assessment process. - The use of visual aids such as charts or graphs to convey complex risk information.

3.2 Network analysis

Network analysis "aims to capture social network dynamics and relationships. Actors in the network are represented by nodes and their relationships as lines"(Choudhary et al. 2022) Different tools are available for this purpose, the most popular of which include Pajek, VOS viewer, HistCite Graph Maker, and Gephi. Gephi was chosen for the citation analysis and VOS viewer for the co-citation and bibliographic coupling because it can effectively handle enormous datasets and offers a variety of creative visualization, analysis, and exploration possibilities. Gephi is "an opensource software package that uses a 3D render engine to develop illustrations of large networks in real-time and assist in speeding up the exploration process"(*Gephi* 2013) And VOS viewer is "a software tool for creating maps based on network data and for visualizing and exploring these maps. It has been developed in the Java programming language. VOS viewer can for example be used to construct maps of authors or journals based on co-citation data or to construct maps of keywords based on co-occurrence data. The program offers a viewer that allows bibliometric maps to be examined in full detail"(van Eck & Waltman 2010).

The data source used as input into VOS viewer is in Plein text file (Web of Science output) containing the bibliographic information of the articles. Our analysis is focused on the following pieces of information: authors, title, journal, publication year, keywords, affiliations, and references. The network analysis is presented in the next section.

Network analysis can be regarded as a set of techniques with a shared methodological perspective, which allow researchers to depict relations among actors and to analyze the social structures that emerge from the recurrence of these relations(Antonio M. Chiesi 2015).

We choose the literature published in WOS database. We use for the search the keyword "supply chain and risk assessment or risk evaluation". Search results are for articles published between 2019 and 2022. The final number of papers is 1387 articles. The documents have 7988 citations in total resulting in 6.49 citation-per-paper. The h-index is 37, implying that out of the 1387 papers, 37 have 37 citations or more. For the chosen sample, a network analysis and graphical investigation are now conducted.

- **Citation analysis:**

A citation analysis is used to examine the degree of connectivity between pairs of nodes/papers in the created node network (Fahimnia et al. 2015). As a complementary analysis, this study also presents a graphical image of the bibliographic material using the VOS viewer software(van Eck & Waltman 2010).

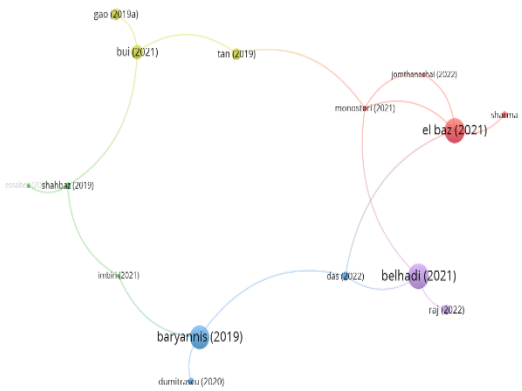

Figure 4. a. Bibliometric analysis of citations
a) The citation of documents

In the figure (a), 5 cluster are identified. Belhadi (2021) is the most cited articles with 228 global citations and 4 local citations (links).

Table 6. Most cited articles

Title	Authors	Year of pub	Citations
Manufacturing and service supply chain resilience to the covid-19 outbreak lessons learned from the automobile and airline industries	Belhadi; et al.	2021	228
Can supply chain risk management practices mitigate the disruption impacts on supply chain' resilience and robustness? Evidence from an empirical survey in a covid-19 outbreak era	El baz, jamal: ruel, salomee	2021	216
Supply chain risk management and artificial intelligence: state of the art and future research directions	Baryannis, George; validi, Sahar; dani, Samir; Antoniou, grigoris	2019	202
Application of Bayesian networks and petri nets in safety, reliability and risk assessment: a review	Kabir, sohag; Papadopoulos, yiannis	2019	126
A framework for risk assessment, management, and evaluation: economic tool for quantifying risks in supply chain	Abdel-basset, Mohamed: et al.	2019	80
Supply chain recovery challenges in the wake of covid-19 pandemic	Paul, sanjoy kumar: et al.	2021	74
Sustainable supply chain management towards disruption and organizational ambidexterity: a data driven analysis	Bui, tat-dat, et al.	2021	66

Source: Web of Science

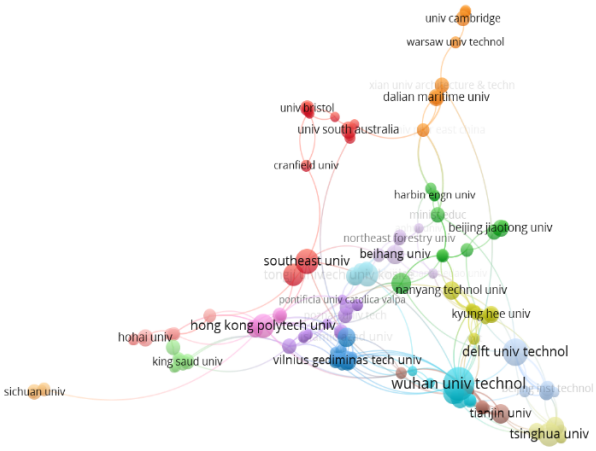

Figure 4. b. Bibliometric analysis of citations
b) The citation of organization

Wuhan university of technology in light blue cluster is the most cited organization (27 documents).

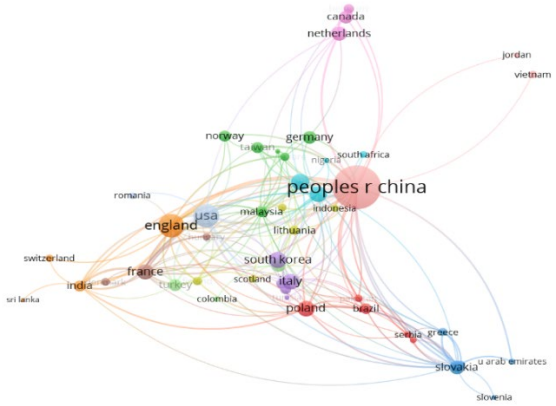

Figure 4. c. Bibliometric analysis of citations
c) The citation of countries

China represents the most cited country with a total of 385 publication and 1554 citation.

Co-citation analysis:

Co-citation analysis is a unique method for studying the cognitive structure of science. Co-citation analysis involves tracking pairs of papers that are cited together in the source articles(Ganesh Surwase et al. 2011).

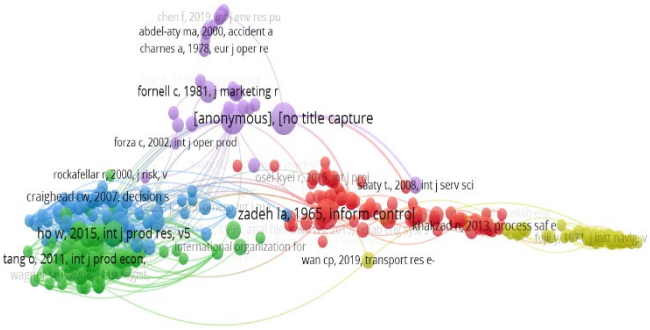

Figure 5. a. Bibliometric analysis of co-citation

a) Co-citation of documents

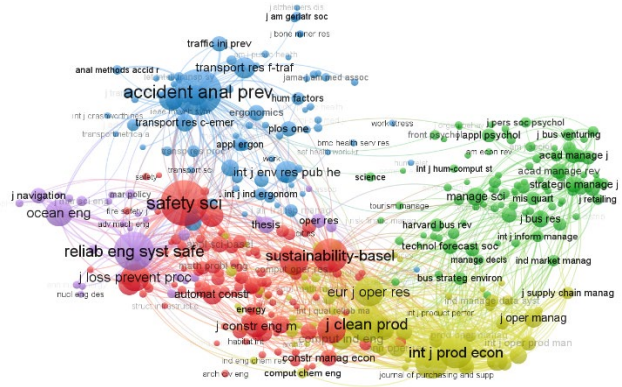

Figure 5. b. Bibliometric analysis of co-citation

b) Co-citation of sources

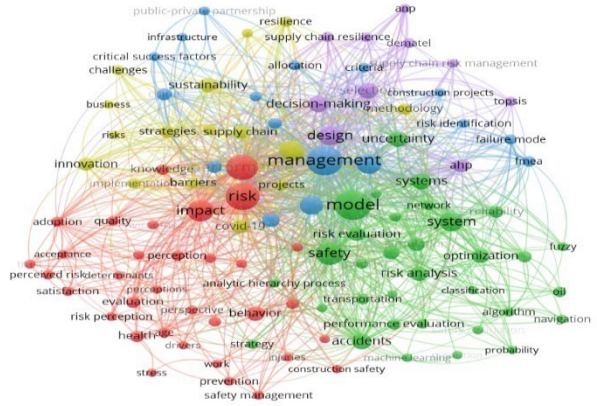

Figure 6. Co-occurrence analysis (Distribution of keyword)

Five clusters are shown in the presented map. The red cluster indicates risk and its characteristics. The blue cluster involved management and the process of managing risks. The green cluster represents risk assessment and analysis. The purple cluster indicates supply chain and decision-making framework. And finally, the yellow cluster referring to sustainability strategies.

Table 7. Most cited articles

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Source: Web of Science

4. Discussion

From our current study, 1387 publications about Supply Chain Risk Assessment indexed in WOS core database were analyzed. The published literatures include the following aspects: risk assessment or evaluation, decision-making methods, and supply chain. China made the most outstanding contribution with is this important field.

Citation analysis:

Table 2 shows the most cited articles on the topic of SCRA. The article entitled " Manufacturing and service supply chain resilience to the covid-19 outbreak lessons learned from the automobile and airline industries " is cited 228 times. This article assessed strategies adopted by two supply chains in the COVID-19 outbreak using a combination of qualitative and quantitative techniques in three distinct phases. On the other hand, " Can supply chain risk management practices mitigate the disruption impacts on supply chain' resilience and robustness? Evidence from an empirical survey in a covid-19 outbreak era " is the second most cited article (216 citations) and it reveals the crucial role of SCRM practices and the prominent role they play in fostering supply chain resilience and robustness using an empirical evaluation of a whole SCRM framework. It should however be noted that generally, the highly cited papers have had sufficient time to establish citations.

As can be seen, in timeframe chosen, the most cited articles treated lessons learned from the Covid-19 pandemic.

Figure 4 represents the linkage of the bibliometric network by documents, organizations, and countries. We saw that China has contributed the greatest number of works followed by England, Italy, USA and South Korea.

This search of the local and foreign literature reveals that 1467 organizations have published the relevant articles, and 25 of them have more than five. Wuhan University of Technology has published 27 related papers and the main partner of the organization is Liverpool John Moores University.

Co-citation analysis:

Totally 1339 authors have been cited at least 5 times. Among them Habil. Dmitry Ivanov, Professor of Supply Chain and Operations Management in Department of Business and Economics in Berlin School of Economics and Law. His research record includes over 390 publications, with over 127 papers in prestigious academic journals. The main collaborators with him are Govindan, Kannan from University of Southern Denmark and Mahdi S. Hosseini from Concordia University.

The bibliographic coupling map of documents and sources are shown in Figure 5a.b. Through the analysis, five clusters were determined. Cluster 1 includes 107 items, and the research area is sustainability and its related risks (shown in red). Cluster 2 include 98 items, and the research area is strategies management of risks (shown in green). Cluster 3 include 80 items, and the research area is risk types (shown in blue). Cluster 4 include 77 items, and the research area is operational risk assessment (shown in yellow). And the cluster 5 include 35 items and the research area is energies risks (shown in purple).

So, it can be concluded that sustainability risk assessment, as a part of sustainability risk management for supply chains, have gained increasing interest in the last few years due to a global population explosion, resource limitations, logistics production and consumption activities corruption, and waste and pollution increase. For example, the work of Essaber, et al. (Essaber et al. 2021b) provide supply chain managers with a formal, general approach offering precise instructions for achieving a 2D performance incorporating both Lean and Green. Adding too, Manel Elmsalmi (Elmsalmi et al. 2021) affirm that neglecting to focus on sustainability risks while considering sustainable development practices (SDP) might disrupt the company's future. So, in this regard, she proposes in its article a classification and ranking of SDPs in accordance with their importance for improved risk management and successful SC performance. Another example presented by Amin; et al. (Amin et al. 2022) in which he evaluate sustainable supply chain risks using a novel fuzzy VIKOR–CRITIC technique.

5-Conclusion

The four SCRM steps are covered by a multitude of techniques and strategies. In this context, risk assessment— in particular—has been the step that has received the most attention especially after the Covid-19 pandemic. So, this paper reviewed the most used methods extracted from 72 articles which are selected from top international journals in the period between 2019 to 2022 and as a result, four methods were analyzed: Analytic Hierarchy Process (AHP), Failure Mode and Effect Analysis (FMEA), Decision Making Trial and Evaluation Laboratory (DEMATEL) and House of risks method HOR. This article provides also a general overview of network analysis of SCRA by indicators including citation and co-citation, to give an idea of the current trends of this field and to help in future operations researches. Nevertheless, many limitations were detected in the realization of this research: Firstly, only a few terms were chosen from a single interdisciplinary database. Secondly, the review excludes conference papers, master's and doctorate dissertations, textbooks, book chapters, unpublished articles, and comments in favor of just international journal articles. Finally, the study's focus was on "the global supply chain" in general, so further research can be conducted into specific areas so that supply chain risks can be evaluated more effectively and efficiently.

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