Safety Risk Analysis Optimization Using Fuzzy: A Literature Review

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Abstract

Risk analysis is procedure to identify risks to the surrounding environment, especially in the workplace. There are several methods for analysing risk. Now days, many risk analysis methods are integrated with optimization methods, such as fuzzy. This approach is used to optimize the results of risk analysis. This study aims to investigate the development of collaboration between risk analysis methods and fuzzy in the industrial sector and research that can be carried out in the future. The authors collected 500 articles from Dimensions.ai between 2018 and 2023 and evaluated the references obtained with the bibliometric analysis tool. The authors analysed the dataset obtained based on the countries that conducted the most research on safety risk analysis optimization and collaboration, themes that were widely used, the themes distribution, and the relationship between existing themes. The Results show that China has published many studies in collaboration with other countries. Research themes that use risk analysis methods are widely used in human assessment where it can be seen in the keywords. Currently, there has been a lot of research on risk assessment integrated with fuzzy and humans. For future research, fuzzy approaches and risk analysis can be integrated with other accident analysis methods.

Keywords: Bibliometric, Fuzzy, Literature Review, Risk Analysis, Risk Assessment

Abstrak

Analisis risiko merupakan prosedur untuk mengidentifikasi risiko terhadap lingkungan sekitar, khususnya di tempat kerja. Ada beberapa metode untuk menganalisis risiko. Saat ini banyak metode analisis risiko yang terintegrasi dengan metode optimasi, seperti fuzzy. Pendekatan ini digunakan untuk mengoptimalkan hasil analisis risiko. Penelitian ini bertujuan untuk mengetahui pengembangan kolaborasi antara metode analisis risiko dan fuzzy pada sektor industri dan penelitian yang dapat dilakukan di masa depan. Penulis mengumpulkan 500 artikel dari Dimensions.ai antara tahun 2018 dan 2023 dan mengevaluasi referensi yang diperoleh dengan alat analisis bibliometrik. Penulis menganalisis dataset yang diperoleh berdasarkan negara-negara yang paling banyak melakukan penelitian mengenai optimalisasi dan kolaborasi analisis risiko keselamatan, tema yang banyak digunakan, sebaran tema, dan hubungan antar tema yang ada. Hasilnya menunjukkan bahwa China telah menerbitkan banyak penelitian yang bekerja sama dengan negara lain. Tema penelitian yang menggunakan metode analisis risiko banyak digunakan dalam penilaian manusia dimana hal ini dapat dilihat pada kata kuncinya. Saat ini sudah banyak penelitian mengenai penilaian risiko yang terintegrasi dengan fuzzy dan manusia. Untuk penelitian

selanjutnya, pendekatan fuzzy dan analisis risiko dapat diintegrasikan dengan metode analisis kecelakaan lainnya.

Introduction

Risk analysis is the process of identifying risks in the surrounding environment or workplace. This is carried out by conducting a risk assessment and identifying hazards that potentially lead to accidents (Ericson, 2005). Risk analysis is the process of developing an understanding of risk. This proposes suggestions or recommendations on whether the risk should be treated, as well as appropriate and cost-effective remediation solutions (Australian/New Zealand Standard, 2004). Risk assessment and analysis is carried out to prevent accidents and work-related illnesses, reduce losses in their activities, and minimize the impacts that may occurred (Mutlu & Altuntas, 2019). In risk analysis, there are many methods that can be used, as an example, namely Failure Mode and Effect Analysis (Wessiani & Yoshio, 2018) and Cognitive Reliability and Error Analysis Method (Karimie et al., 2018).

Risk assessment and analysis have been carried out in numerous industrial areas and phenomena over time. Many researches have used risk analysis as a way for analyzing various objects. Technological advancements are also vital for the ease of the risk analysis process in order to deliver appropriate assessment and analysis results.

Many recent researches shave been combined analysis and risk assessment with optimization. In the optimization process, often using computer applications or algorithm, such as integrating it with fuzzy. For example, integrating FMEA and Fuzzy (Mandal & Maiti, 2014; Wessiani & Sarwoko, 2015; Yang & Wang, 2015). Aside from that, there are others that integrate Fuzzy with Analytical Hierarchy Process (Jabbari et al., 2021). The other combines Fuzzy Bayesian with CREAM (Abbassinia et al., 2020; Zhou et al., 2018). Another example of risk analysis and fuzzy integration is Hazard Identification and Risk Assessment and fuzzy that applied on material handling using forklift (Aufarisza et al., 2017). This type of integration method has been widely applied to investigate a wide range of objects, including persons, the environment, occupational disorders, and so on.

With so many studies integrate these methodologies, we can synthesize these studies using a literature review. As the quantity of scientific publications produced increase (Bertoglio et al., 2021), it is essential to do a literature review. A bibliometric is one of the instruments used to conduct a literature review (Luis Aleixandre-Tudó et al., 2018; Maditati et al., 2018). Bibliometrics is a way for conducting a systematic, objective study of scientific activity that may be replicated in the future. Bibliometrics is the application of quantitative and statistical analysis to published research in order to assess its impact (Bertoglio et al., 2021). This bibliometric analysis aims to evaluate scientific works or research on the subject or approach in order to advise future research directions and methods (Aria & Cuccurullo, 2017; Armenta-Medina et al., 2020; Raparelli & Bajocco, 2019).

There are many researches have used literature review with basic theme risk analysis. For example, literature review of occupational safety risk analysis in construction project. This research aims to identify risk level of a potential hazard and controlling the hazard (Friyandary et al., 2020). There is another example literature review about analysis of Potential Work Accident in Construction Project Using the Hazard Identification, Risk Assessment, and Risk

Control Method, this research reviews the similarities of 8 articles or researches by the methodologies, issues, and the goals. The author's finding is the jobs that have high risk level and average risk level (Magda et al., 2023). From another literature review in healthcare sector, it is about the occupational safety and health (OSH) risk factor in healthcare workers during pandemic era. This research's goal is to determine the risk factor related to OSH (Surya et al., 2021). Below is the list of few articles that conduct the same themes (literature review of safety risk analysis or risk analysis optimization) from national articles and international articles.

Table 1. Gap of Articles

Article identity	Overview of articles	Method and Variable			
		Literature Review	Risk Analysis	Fuzzy integrated	Object
(Rafieyan et al., 2022)	Using holistic literature review from few articles to define the key factors that leading to the occurrence of construction accident that caused by human error. After that, Fuzzy and SWARA were conducted to assess the score of key factors.	√	√	√	Key factors of accident in Construction
(Friyandary et al., 2020)	Literature review of occupational safety risk analysis in construction project. This research aims to identify risk level of a potential hazard and controlling the hazard	√	√		Risk level in construction project
(Magda et al., 2023)	Literature review about analysis of Potential Work Accident in Construction Project Using the Hazard Identification, Risk Assessment, and Risk Control Method, this research reviews the similarities of 8 articles or researches by the methodologies, issues, and the goals.	√	√		Define type of risk level in construction project

(Surya et al., 2021)	Literature review in healthcare sector, it is about the occupational safety and health (OSH) risk factor in healthcare workers during pandemic era.	√	√		Determine risk factors in Healthcare Workers
(Agusman et al., 2021)	Identifying risk that can lead in construction project by reviewing few of articles or literature study.	√	√		Focus on identifying risk and classifying risk category in Construction
(Pamungkas et al., 2023)	Conduct literature review about machine failure risk by classifying the method that used by selected articles.	√	√		Focus on machine failure risk.
This article	Using literature review to identifying the trend of research in safety risk analysis that integrated with optimization method. Analyzing is use bibliometric analysis	√	√	√	Focus on the trend of optimization method of safety risk analysis theme in all type sectors.

Source: Primary Data, 2023

According to the few examples of researches that conduct a literature review especially in risk analysis above, we can know there is a gap between another research with this research, that is there are not yet researches that have a goal to classify the researches in general especially from international articles and identify the research's trend. Therefore, this study aims to classify and review existing studies using bibliometric analysis, then can identify a research's trends that using this method integration in the future.

Research Method
a.   Materials

To conduct a literature review with bibliometric analysis, we used the application bibliometrix R package and VOSviewer. In collecting article data, we collected articles from Dimensions.ai, then it is processed using these two applications.

b.   Methods

This research focuses the theme of literature reviews of research related to Fuzzy Risk Analysis, especially industrial safety. After obtaining the data through Dimensions, the next step is to carry out data analysis by using bibliometric tools and VOSviewer. After analysis, the data and analysis are visualized and the results interpreted.

1) Study Design

This study retrieves data by using predetermined keywords, that is Fuzzy Risk Analysis. the timespan data were used is from 2018 to 2023 on the Dimensions website. This was decided to see the update of the uploaded articles.

2) Data Collection

Article data is collected using predetermined keywords. Data was taken from 2018 to 2023 on the Dimensions website. In the first collection, 223,685 articles were obtained which were assessed as related to these keywords. After that, filtering is carried out where only open access articles are taken. So that, at this stage we obtained 500 articles. We collect data from Dimensions following the following criteria:

- **Topic and keyword:** "Fuzzy", "Fuzzy Risk Analysis" or "Fuzzy Risk Analysis in Industrial Safety"

- **Timespan:** 2018 – 2023

- **Language:** English

3) Data Analysis

In Bibliometrics, there are many methods that can be used, such as citation analysis, co-author analysis, co-word analysis, and so on. These analyzes can be used as needed (Zupic & Čater, 2015).

4) Data Visualization and Interpretation

Data visualization consists of various graphs that show the results of bibliometric data analysis. Data obtained from bibliometrics and also VOSviewer can be in the form of bar charts, lines, networks and other images. Furthermore, from this graph, analysis results can be interpreted.

Result and Discussion

After collecting data, the next step is to carry out a bibliometric analysis of the studies that have been collected. This analysis uses bibliometric tools and VOSviewer. The results of the analysis are grouped into 3 main groups, they are countries that have carried out a lot of research related to fuzzy and risk analysis as well as collaboration in their research, the themes that are mostly raised in the use of these methods and the distribution of the themes and the interrelationships between themes.

According to the results of bibliometric analysis, of the 500 articles throughout 2018 – 2023, China is the country that produced the most articles using fuzzy methods and risk analysis. Figure 1 shows that China is also the country that produces the most research in collaboration with one country or another, namely 148 articles collaborating with the country itself or single country publications (SCP) and 21 articles collaborating between countries or multiple country publications (MCP).
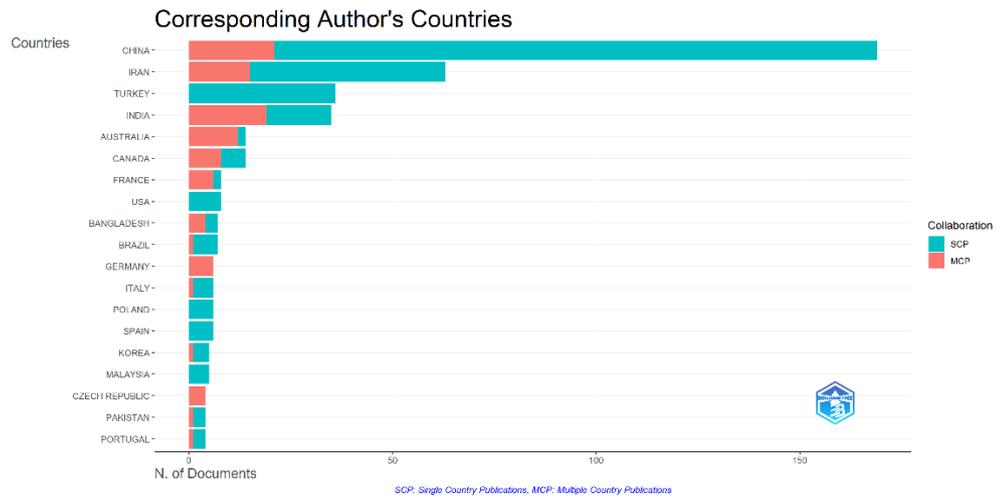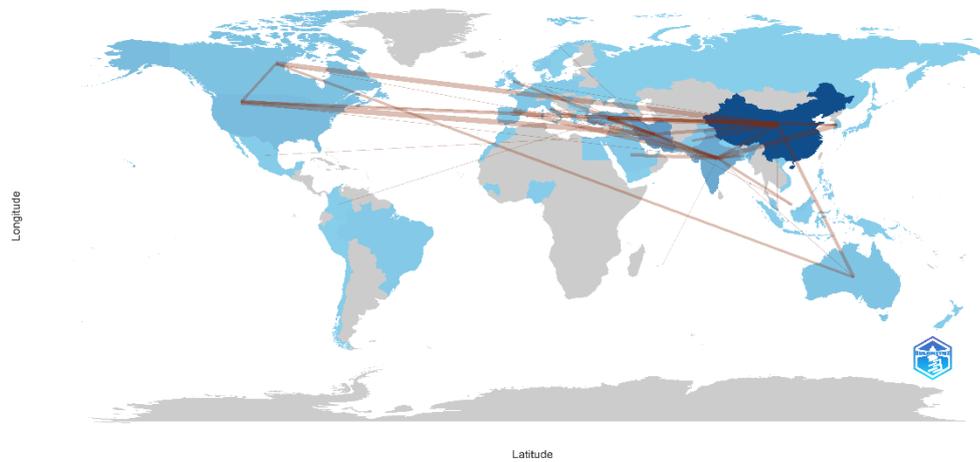
Figure 1. Corresponding author's country

Another that, in Figure 2 shows the distribution of author collaborations that have been carried out a lot. This collaboration is carried out with one country or between countries. Iran and the USA are ranked 1st for collaboration between countries. Then the next rank is collaboration between China and Canada.


Figure 2. Country collaboration map

Figure 3 shows a theme map of research conducted from 2018 to 2023. The theme map shows that many authors have raised the themes of risk assessment and fuzzy logic. Apart from that, many authors have linked it to humans. This can be seen from the keywords that are widely used and appear in these studies. In addition, some use it to assess risks to accidents and the environment.
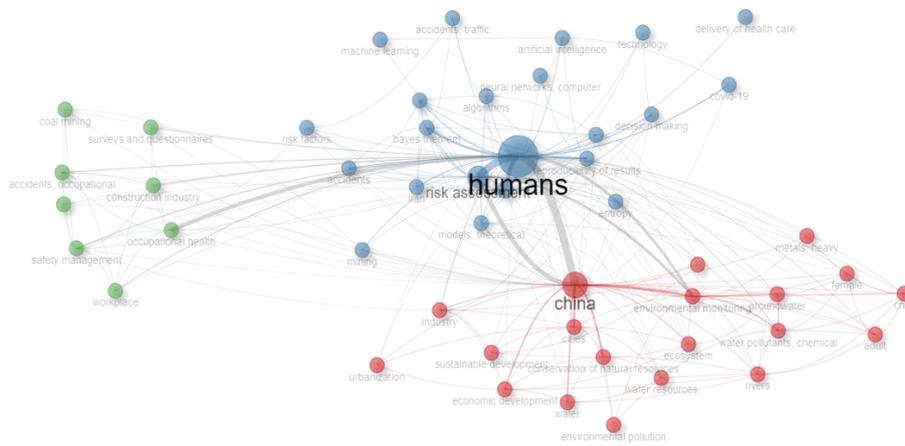
Figure 3. Thematic map

In addition, Figure 4 also confirms that there is a connection between the themes of risk assessment, fuzzy logic and humans. The theme is in the lower right quadrant, which means it is fundamental with high centrality but low density. In addition, themes in the upper right quadrant should be developed and studied further because of their high density and centrality, the theme is environmental monitoring.
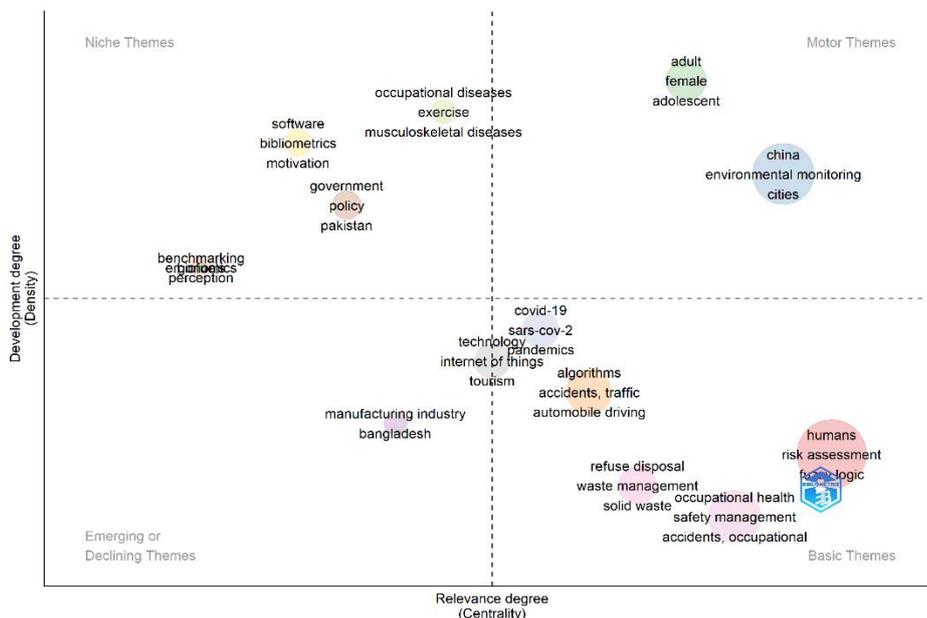

Figure 4. Density

By using VOSviewer we can find out research trends with themes that are developing from year to year. In Figure 5, it can be seen that research trends using fuzzy and failure mode effect analysis are developing from 2021 until now. This can be seen from the color (light green and yellow). Therefore, future research can be carried out using the latest themes and

also can be carried out with objects in the environment and humans.
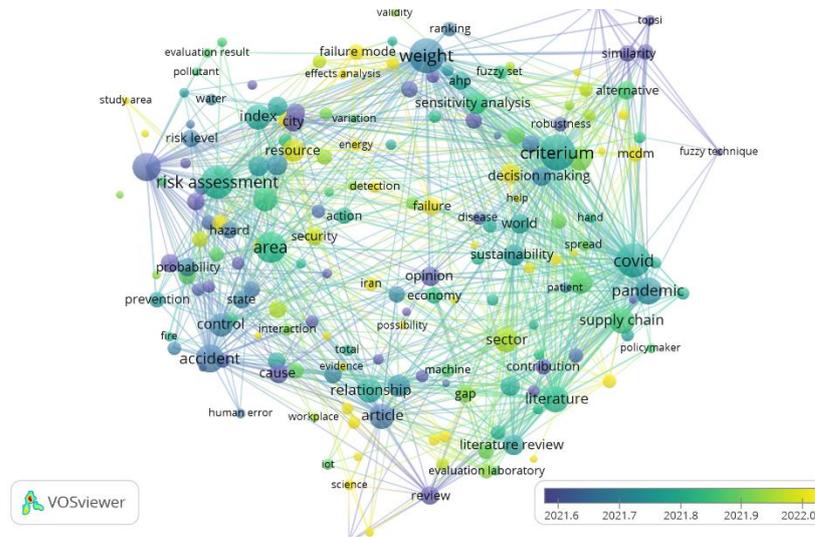
Figure 5. Thematic map overlay by year

Conclusion:

From data results, interpretation and discussion above, we can conclude that China is the country that publishes the most articles using fuzzy methods and risk analysis and as well as the country that produces the most research that collaborates both with one country and with other countries. Many authors have used the theme of risk assessment and fuzzy logic. Besides that, many authors also have linked it to humans. Research using fuzzy and risk assessment and analysis is often used on human objects. Research using fuzzy and failure mode effect analysis is currently developing from 2021 until now. For future research, fuzzy and risk analysis can also be carried out with objects in the environment and humans.

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