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Bibliometric analysis applied to the analysis and investigation of accidents in high risk industries

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The application of accident analysis and investigation techniques as a tool to prevent unwanted events has been of great importance in several organizations, mainly in high risk industries, such as: mining, nuclear, maritime, oil and gas, aviation and others. This article is a bibliometric research that aims to identify which are the main accident investigation methodologies that have been used in high risk industries. The article also proposes to identify how many usual methods of analysis and investigation of accidents exist and, consequently, to identify who are the main authors. And finally, the article researched the differences and similarities between the accident investigation methodologies used in industries in general and compared them with the aviation industry.

Keywords: Accident, Incidents, analysis, accident prevention, Risk assessment, investigation.

1. Introduction

According to Donthu et al., 2021, the use of bibliometrics is gradually extending to all disciplines. It is particularly suitable for science mapping at a time when the emphasis on empirical contributions is producing voluminous, fragmented, and controversial research streams.

Bibliometric analysis is a widely adopted and rigorous method for exploring and analyzing large volumes of scientific data (Peron et al., 2022).

Due to the relevance of the subject, some institutions specialized in representing specific sectors of high risk industries have published reference information on the analysis of accidents and lessons learned. These institutions can be both governmental and non-governmental. Although the events investigated by these institutions do not cover all the incidents that occurred, they cover the most significant events. We can mention two institutions that carry out extensive work in this regard.1- The Norwegian Safety Investigation Authority, known as the Norwegian Safety Investigation Authority (NSIA, 2023) ,is a government agency responsible for investigating aviation, maritime, road, rail incidents and accidents. and in the defense sector in Norway. 2- The U.S. Chemical Safety and Hazard Investigation Board (CSB, 2023) is an independent agency in the United States that has duties similar to NSIA, but CSB focused on events related to chemical industries and process safety events.

2. Materials and Methods

This article is the result of an occupational safety and health research, focused on accident analysis. With the use of these 2 databases: Web of Science and Scopus, (Capes, 2023), we will generate the

following information: Main Information about data, Documents Sources (Journals, Books, etc.).

First, to start this work, a bibliometric search was carried out in July 2022, with the terms "Accident?" And "Investigation? “or "incident?" or "near" and "miss" or "Analise" AND "Acident?" or "incident" AND "analysis" or "mishap" or “near hit” or “close call” in the title, abstract, and keywords. The objective was to find articles models,(Wienen & Allah Bukhsh, 2017) related with high risk industries, in companies linked, such as: mining, nuclear, maritime, oil and gas, aviation and others.

Scopus and Web of Science databases will be used, and the R Can Software will be used as support software.

The R Cran software allows you to view the results on the Web of Science page itself by simply clicking on "Analyze Results" and choose the preference options in your search.
Average citations per documents, Authors, Author Appearances, Authors of single authored, documents, Authors of multi authored documents, Documents per Author, Authors per Document, Co-Authors per Documents, Collaboration Index, Annual Scientific Production, Year Articles, Most Productive Authors, Top manuscripts per citations. Within the Bibliometrix package there is a "Biblioshiny" application, which enables the mapping of scientific literature, Aria & Cuccurullo, 2017,after entering the code into the R CRAN, a web window opens for bibliometric analysis in a more user-friendly interface.

In this software it is possible to use the package "bibliometrix" that provides a set of tools for quantitative research in Bibliometrics, allowing import and conversion of data to the R format; bibliometric analysis of a publication dataset; construction of matrices for co-citation, coupling, collaboration and joint analysis (ARIA & CUCCURULLO, 2017)

3. Results

The monitoring of the engagement of the manager and the investigation team in the analysis of accidents brings an important panorama of the evolution of the cultural aspects of occupational safety and that can reflect in the index of occurrences of events. According to the researcher team, the monitoring of these parameters is considered fundamental, not only in the analysis meeting of the event, but also later, in the management of the information obtained and sequencing of the same. Table 3 shows the distribution of values by state.

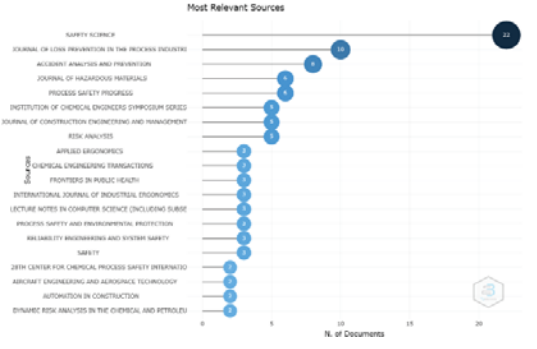

Fig.1. Most relevant sources

The Fig. 1, Most relevant sources, correspond to around 40%, which are: Safety Science, Journal of loss prevention in the process industries and Accident Analysis Prevention.

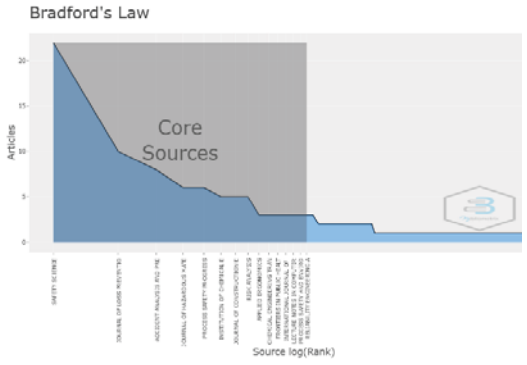

Fig.2. Bradford´s Law

Fig.2, with respect to the top 3 sources are also the top source of articles, according to Bradford's Law.

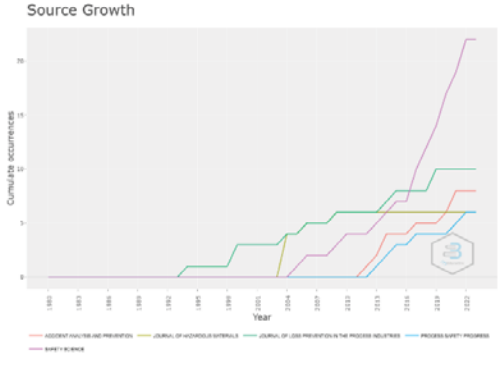

Fig.3. Source Growth

The analysis of cumulative occurrences highlights Safety Science from the year 2015, followed by Journal of loss prevention in the process industries, which is a reference from 1992, being the second most relevant today.

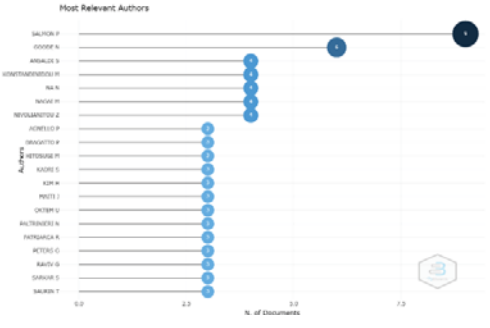

Fig.4. Most relevant authors

Regarding the most relevant authors, between the 3rd and 4th place we have several authors with the same number of articles. Highlight for the first and second most relevant authors Paul Salmon and Natassia Goode, with 9 and 6 articles respectively.

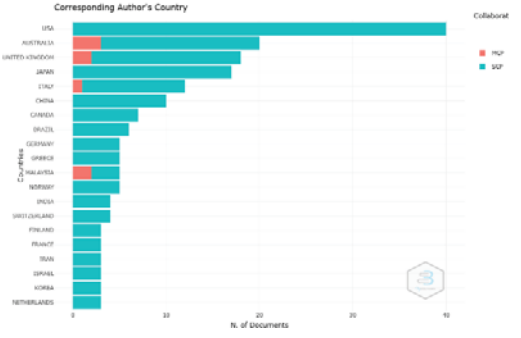

Fig.5. Corresponding Author´s Country

The analysis of SPC: Single Country Publications, MCP: Multiple Country Publications, shows us a greater tendency for SPC in all countries and a greater individual contribution of the following countries: USA, Australia and United Kingdom.

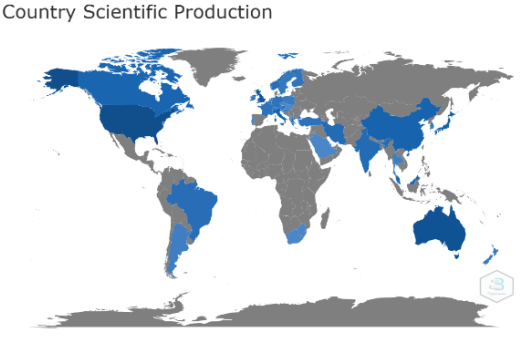

Fig.6. Country collaboration map

Table 1. Distribution of Country contribution

Region	Freq
Usa	**68**
Australia	**47**
Uk	**39**
Japan	**22**
Italy	**19**
China	**18**
Canada	**16**
Malaysia	**15**
India	**10**
Iran	**10**
Brazil	**9**
Norway	**9**
Belgium	**7**
Turkey	**7**
France	**6**
Germany	**6**
Austria	**5**
Finland	**5**
Greece	**5**
Ireland	**4**

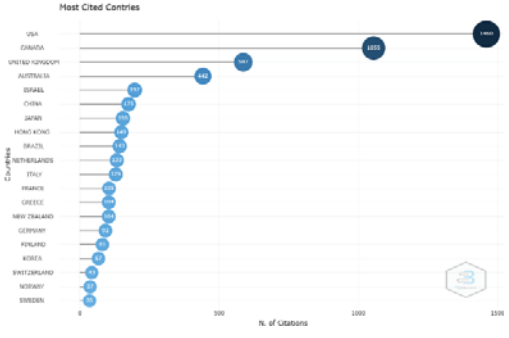

Fig.7. Most cited countries

The analysis of (Fig.7) Most cited countries, demonstrates two important analyses: First is that most citations are concentrated in the first 4 countries and second analysis is the highlight in Canada, which in (table.1) is in seventh place.

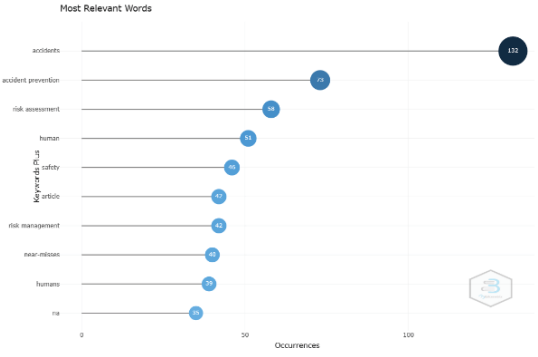

Fig.8. Most relevant words

Fig.12. Most frequent words

Table 2. Distribution of most frequent words

Terms	Frequency
Accidents	**132**
Accident prevention	**73**
Risk assessment	**58**
Human	**51**
Safety	**46**
Article	**42**
Risk management	**42**
Near-misses	**40**
Humans	**39**
Na	**35**

The distribution of the most frequent words brings the first three: Accidents, Accident prevention and Risk assessment. These terms are very frequent in consolidated reports, articles and periodicals.

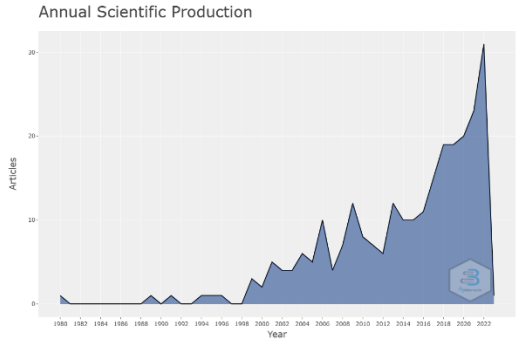

Fig.15. Annual scientific production

The graph shows an evolution in the number of production of scientific articles, mainly from 2016, and in 2022 practically tripling the number of articles.

4. Discussion

One of the limitations of the study is that the search period was from 2018 to 2022. As there are many accident analysis techniques, it is known that the search parameters should be broad, in order to obtain and reach the information sought.

Although the preliminary results presented in this study are promising, it is essential to recognize that more research is needed using different search keywords and criteria to confirm and complete the proposed initial objectives. The limitations identified in this study provide us with valuable insights for future research, in high risk companies, such as: chemical, petrochemical, mining, oil and gas industries, among others, which should consider more comprehensive approaches and larger samples, based on a search for scientific articles with greater relevance to the objectives of this study.

By presenting an overview of the current scientific literature on accident investigation and analysis studies, these results will allow identifying key topics that have received little attention or that have been little explored so far. This, in turn, will make it possible to formulate guidelines for future research and carry out studies that fill these gaps, expanding and deepening existing knowledge.

The studies included in this bibliometric search did not provide the expected results in terms of the amount of accident investigation techniques used in high risk industries, as indicated by the keywords. Furthermore, it is important to emphasize that we cannot state that the accidents investigated in these industries are being adequately represented by means of scientific articles.

The independent institutions NSIA and CSB, on the other hand, make several investigations available on their respective websites and have their own framework for investigating accidents. However, it is important to note that these frameworks do not fit the traditional methodologies commonly used.

5. Conclusions

Through the research with the researched terms and in the two databases, it was possible to obtain relevant information. With the use of search terms, or keywords, it was not possible to identify all the objectives proposed for the article.

One of the main unachieved objectives was to identify the mapping of the amount of investigation techniques in righ risk organizations.

Through the analysis of Bradford's Law, we identified the main journals that publish on this topic.

For researchers on the subject of analysis and investigation of accidents, the 3 most relevant sources correspond to about 40% of publications on the subject, which can facilitate research on the subject.

The authors identified in the most relevant works demonstrate that the results bring authors of the present time and also authors of the fundamentals of the theme of analysis, investigation and techniques on the subject.

In order to satisfy the proposed objectives, new research should be carried out, correlating the specific areas of activity of high risk companies and accident analysis techniques.

Not all high risk organizations systematically make available the accident investigation techniques that have been used through scientific articles.

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