



RESEARCH ARTICLE

## The bibliometric analysis and visualization mapping of research on maritime accidents

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### ABSTRACT

The purpose of the study was to assess the output of research on maritime accidents and citations from 2000 to 2022 through a bibliometric analysis. Utilizing the visualization and mapping program VOSviewer 1.6.18, the relevant data was extracted from the Web of Science (WoS) database and analyzed. The findings indicated important study fields, country contributions, productive journals, as well as the most cited authors' articles. The primary findings were as follows: The most influential journal was Safety Science. One of the most common topics of study for maritime accidents was the human factor. The most productive country was the People's Republic of China. The findings of the study can assist researchers in conducting their studies more effectively by providing information about the journals they may use, the authors who contributed to it, current research trends, countries, and keywords.

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### Introduction

Since the beginning of shipping, maritime accidents, which is unwanted anomalous occurrences aboard a ship that frequently cause fatalities, serious injuries, and different sorts of property damage, have been a significant problem for the global maritime community (Luo & Shin, 2019). Marine accidents constantly happen, causing significant harm to both people and the environment, despite ongoing advancements in maritime

technology and safety management (Shi et al., 2021). Over the years 2014 to 2021, there were 21,173 reported marine accidents and incidents, with 2,647 occurring on average per year (EMSA, 2022).

Numerous studies have been conducted on marine accidents in an effort to reduce them and improve maritime safety. Examining the studies on maritime accidents reveals that various types of accidents, particularly grounding and collision, are the subject of research. Graziano et al. (2016) have proposed

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a new approach by analyzing grounding and collision incidents and integrating the Technique for the Retrospective and predictive Analysis of Cognitive Errors (TRACER) with the accident analysis technique of CASMET. A statistical analysis of AIS data and marine accident data from Norwegian waters was also carried out by Bye & Aalberg (2018) to determine the factors that led to collision and grounding accidents. In collision and contact accidents on passenger ships, human factor analysis has been carried out by Uğurlu et al. (2018).

Whereas numerous studies have highlighted the significance of human and organizational factors in marine accidents (Hetherington et al., 2006; Schröder-Hinrichs, 2010; Chen et al., 2013; Qiao et al., 2020), others focus on risk analysis (Awal & Hasegawa, 2017; Fan et al., 2020a, 2020b; Kulkarni et al., 2020). There are also studies utilizing methods like root cause analysis, HFACS and Bayesian networks (Hänninen & Kujala, 2012; Montewka et al., 2014; Kum & Sahin, 2015; Kececi & Arslan, 2017; Akyuz, 2017; Batalden & Sydnes, 2014; Soner et al., 2015; Yıldırım et al., 2019).

Hetherington et al. (2006) carried out a literature review on the topic of ship safety, focusing on three key areas: common accident causes, human error, and efforts to improve maritime security. Fatigue, stress, health, situational awareness, teamwork, decision making, communication, automation, and the prevalence of a culture of safety were all factors in their analysis. In their research, Chen et al. (2013) also proposed a Human and Organizational Factors (HOFs) framework for the investigation and analysis of maritime accidents. But Qiao et al. (2020) claims that because there is a paucity of data concerning human factors in the shipping industry, evaluating the role of human factors in maritime accidents is challenging.

According to Kulkarni et al. (2020) accidents can be avoided by assessing the risk in waterways and maritime areas and linking it to preventive actions that improve navigational safety. Fan et al. (2020b), similar to Kulkarni et al. (2020), stated that, because the majority of marine accidents have a low likelihood but serious consequences, risk assessment is important for shipping operations. However, Awal & Hasegawa (2017) state that while risk analysis is frequently employed in the maritime context, its usage is restricted to risk control options. According to the research of Fan et al. (2020a), 'ship age', 'ship operation', 'voyage segment', 'information', and 'vessel condition' are the key risk influencing factors for different types of marine accidents.

Kum & Sahin (2015) have carried out root cause analysis for accidents that occurred in the Arctic Region between 1993 and 2011. Kececi & Arslan (2017) proposed a new taxonomy in their

study that incorporates root cause taxonomies that have been applied up to now in the examination of maritime accidents (Kołakowski et al., 2022).

There have been several studies on various accident types using a variety of methodologies in a number of different countries, so research is required to better comprehend the arrangement of information on maritime accidents. Therefore, this study attempts to improve the contribution of all previous studies by conducting a bibliometric analysis of the maritime accident literature.

It has been noted that bibliometric analysis studies are conducted in the maritime industry on various subjects (Mao et al., 2010; Lau et al., 2017; Munim et al., 2020; Meyers et al., 2021; Bolbot et al., 2022; Büber & Köseoğlu, 2022; Kołakowski et al., 2022). Utilizing bibliometric analysis, Mao et al. (2010) have analyzed the global scientific output of risk assessment research over the previous sixteen years and provided insight into the study's characteristics and trends. Lau et al. (2017) have examined the collaborative and semantic patterns in container shipping articles published between 1967 and 2013 in the journals of transportation, supply chain management, economics, geography, regional planning, and operations research. Munim et al. (2020) have conducted a bibliometric analysis of 279 research on the uses of big data and artificial intelligence (AI) in the marine sector, which were published in 214 academic journals from the Web of Science database. Meyers et al. (2021) have conducted a Scopus-based bibliometric analysis of marine research that included the Automatic Identification System. Büber & Köseoğlu (2022) conducted a bibliometric study of oil spill response research output and citations from 2000 to 2022. Kołakowski et al. (2022) have applied a bibliometric method to a sample of 234 scientific papers indexed in the SCI-EXPANDED collection of Clarivate Analytics' Web of Science Core Collection in order to critically analyze the research trends concerning the active methods for reducing the negative environmental impact of shipping. Bolbot et al. (2022) have performed a bibliometric analysis of maritime cybersecurity-related papers using several metrics and analytical techniques to determine academic research topics, methodologies, and major research concerns and directions.

Although significant bibliometric analysis studies have been conducted in diverse fields, there are few bibliometric analyses focused on marine accidents (Kulkarni et al., 2020; Gil et al., 2020; Dominguez-Péry et al., 2021; Fu et al., 2021; Wróbel, 2021). A bibliometric study of risk management studies with a focus on the Baltic Sea region has been presented by Kulkarni

et al. (2020). Similarly, Fu et al. (2021) conducted a bibliometric study of the scholarly literature on the risk management of Arctic shipping. Gil et al. (2020) have conducted a bibliometric analysis and systematic evaluation of shipboard decision support systems for accident prevention. Dominguez-Péry et al. (2021) performed a bibliometric analysis of human error-related marine accidents. In order to confirm the widely held opinion that humans are responsible for about 80% of accidents and to determine their origins, Wróbel (2021) has conducted a literature review. Even if there are a few bibliometric analysis studies on marine accidents in the literature, a comprehensive bibliometric study appears to be necessary. We believe that our research will fulfill this gap in the literature.

The structure of this paper is as follows: The second section describes the study's methodology and provides a concise explanation of bibliometric analysis. The third section gives the results of a bibliometric study of papers on marine accidents and displays the many viewpoints on network structure based on bibliographic matching, citation, and keyword concurrence. The fourth section discusses the outcomes and provides information for future studies.

## **Materials and Methods**

Bibliometric analysis is a method of document analysis technique that involves of bibliometric theory to examine related material using mathematical and statistical techniques (Zou et al., 2018). Bibliometric techniques are being utilized more often to research various scientific topics and to evaluate institutions and universities globally (Ellegaard & Wallin, 2015). By understanding the meaning of massive amounts of unstructured data in a systematic manner, bibliometric analysis is valuable for unraveling and charting the cumulative scientific knowledge and evolutionary subtleties of established domains (Donthu et al., 2021). By examining the production of publications, keywords, authors, institutes, and nations, bibliometric approaches offer a means to pinpoint development patterns or future research directions (Chen et al., 2016; Li et al., 2015). Web of Science (WoS), Scopus, Science Direct, and Google Scholar are just a handful of the academic databases and search engines that are readily available, and they all make it much easier to find and retrieve scientific papers for bibliometric research (Wong et al., 2020). The world's most popular platform for searching and analyzing scientific citations is the Web of Science (WoS), and it is utilized as a research tool to support a wide range of scientific activities across many knowledge areas as well as a dataset for extensive

investigations involving massive amounts of data (Li et al., 2018). Consequently, bibliometric analysis was performed with the data obtained from the WoS database in this study.

This article describes the outcomes of bibliometric analysis and visualization of a variety of scholarly works. Therefore, the purpose of this article is to identify the global research trends for the terms "maritime accident\* or marine accident\*" as well as the most productive authors and publications. This study makes a methodological contribution to the field of maritime accident by presenting a bibliometric mapping that allows for the evaluation of scientific presentation as well as its visual analytics using five bibliometric mapping techniques (co-occurrence keyword analysis, abstract keyword analysis, author citations analysis, citation country analysis, and citation source analysis). This allows for a better understanding of the field's structure and evolution. Despite extensive research on bibliometric analysis from a range of disciplines, there are only a limited number of publications on the application of bibliometric studies to marine accidents.

On November 24, 2022, the whole data set—limited to English and the article document type—was retrieved from WoS. Book Chapters or Early Access or Proceeding Papers were excluded from the dataset. The terms "Maritime Accident\*" or "Marine Accident\*" are used in the WoS search engine. This search found 570 studies on the topic that were published between 2000 and 2022.

The bibliometric analysis in this study was carried out using the VOSviewer (version 1.6.18) software. The software VOSviewer enables the creation and visualization of bibliometric maps (Md Khudzari et al., 2018).

The objectives of this study are to: 1) provide a thorough overview of the evolution of research on maritime accidents; 2) identify the distribution of the most productive journals and contributing countries; 3) identify the most common relevant keywords; and 4) identify the authors who have contributed the most.

## **Results**

Table 1 displays the top 10 articles by search query that were cited the most throughout the specified duration, with Chauvin et al.'s (2013) article leading the list with 287 total citations. The significance of bridge resource management for pilot-on-board navigation in restricted waterways is the focus of this most-cited paper. In the article, collision accidents were examined and HFACS was used as a method. It can be seen that the most cited article was published in the Accident Analysis and

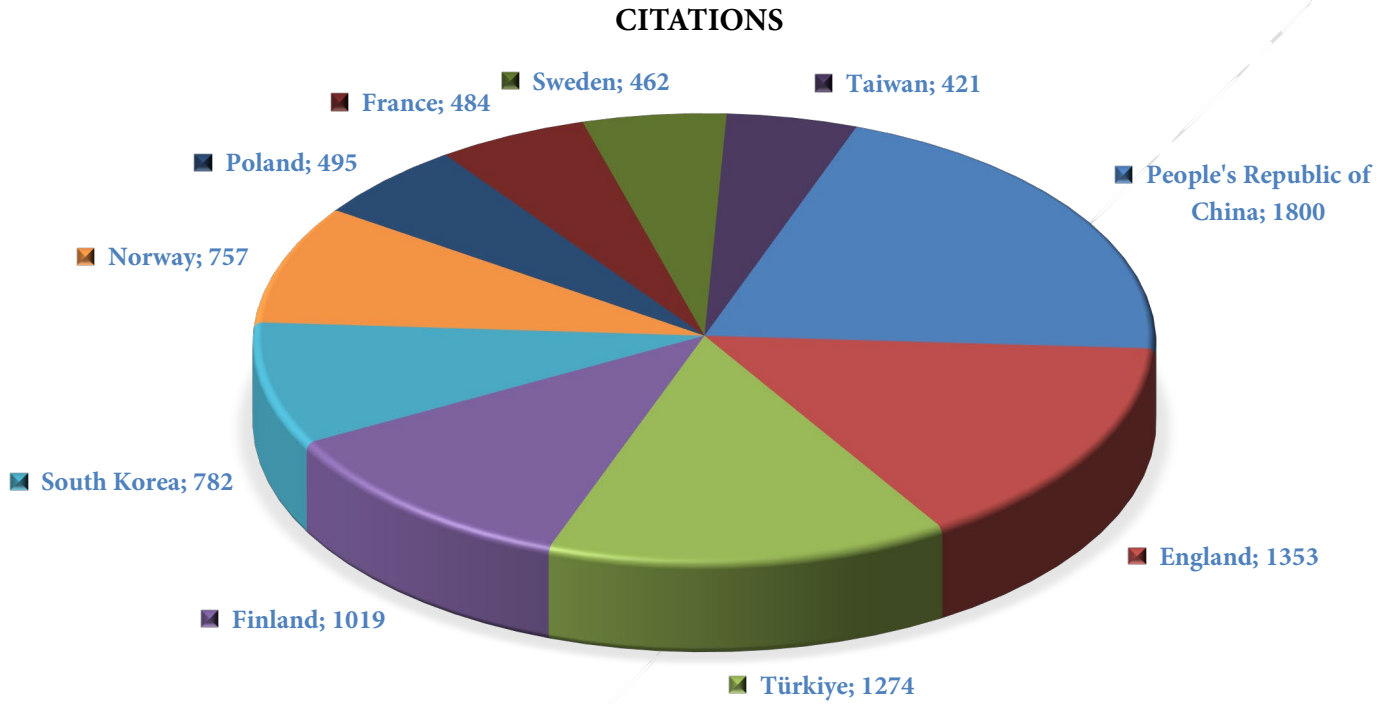


**Table 1.** Top-cited articles with information related to searching query (“marine accident\*” or “maritime accident\*”)

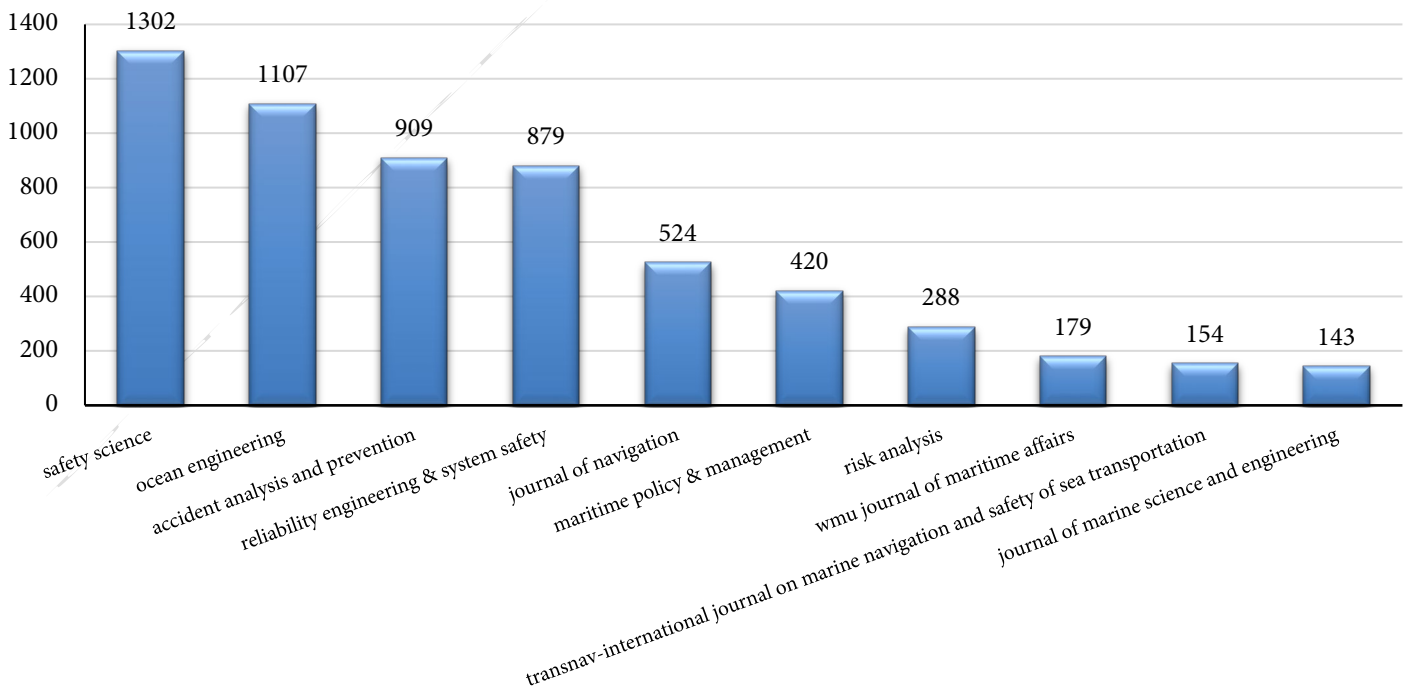
ID	Authors and Publication Year	Source Title	Publisher and WoS Category	Total Citations	Scientific Contribution	Aim of the Study	Methodology	Research Sample	Category Quartile	Impact Factor
1	Chauvin et al. (2013)	ACCIDENT ANALYSIS AND PREVENTION	Elsevier; Transportation	287	This study demonstrates the significance of bridge resource management for pilot-on-board navigation in narrow waterways.	to classify accident types with various patterns of human and organizational factors in order to present a methodical and multifactorial analysis of collisions at sea.	Human Factor Analysis and Classification System (HFACS).	Collision Accidents	Q1	6,376
2	Harati-Mokhtari et al. (2007)	JOURNAL OF NAVIGATION	Cambridge University Press; Engineering, Marine	213	According to this study, a number of stakeholders, including regulatory authorities, need to do more for the AIS to achieve its stated goals and purposes.	to investigate the AIS's (Automatic Identification System) implementation on ship bridges and any potential effects on marine navigation safety.	“Swiss Cheese” Model	AIS studies	Q2	2,647
3	Montewka et al. (2014)	RELIABILITY ENGINEERING & SYSTEM SAFETY	Elsevier; Engineering, Industrial	159	This study establishes a holistic risk model for the maritime transportation system.	to develop a systematic and proactive framework for determining the risk.	Bayesian Belief Networks	Open Sea Collision Involving a Ro Pax	Q1	7,247
4	Hänninen & Kujala (2012)	RELIABILITY ENGINEERING & SYSTEM SAFETY	Elsevier; Engineering, Industrial	143	The model demonstrates that altering direction during an encounter is the most important component, followed by aspects like the officer of the watch's activity, situational evaluation, threat detection, personal condition, and incapacity.	to determine the elements that significantly affect the probability of ship collisions in the Gulf of Finland.	Bayesian network	Collision Accidents in the Gulf of Finland	Q1	7,247
5	Chen et al. (2013)	SAFETY SCIENCE	Elsevier; Engineering, Industrial	132	This study suggests a new HFACS analogy for examining and evaluating marine accidents. This study suggests a new HFACS analogy for examining and evaluating marine accidents.	to provide a particular Human and Organizational Factors (HOFs) framework for the investigation and evaluation of maritime accidents.	Human Factors Analysis and Classification System for Maritime Accidents (HFACS-MA)	Herald of Free Enterprise	Q2	6,392
6	Wróbel et al. (2017)	RELIABILITY ENGINEERING & SYSTEM SAFETY	Elsevier; Engineering, Industrial	130	The findings indicate that as autonomous ships become more common, navigational accidents should become less common. But it's likely that accidents on unmanned ships will have a lot more serious effects than on regular ships, especially if they don't happen while the ship is in navigation.	to evaluate whether the accident would have occurred if the ship had been unmanned and whether the consequences of the accident would have been different if it had.	HFACS-MA and What-If Analysis	100 Maritime Accident Reports	Q1	7,247
7	Eleftheria et al. (2016)	SAFETY SCIENCE	Elsevier; Engineering, Industrial	123	The study shows that, even though there have been more ship accidents in general over the past ten years, the safety level of different types of ships has not changed much, and neither has the average severity of their effects.	To evaluate the safety of all fundamental categories of merchant ships in terms of accidents' occurrence, initial frequencies, and fundamental outcomes. To quantify the risk level of the operating world fleet by statistical analysis of historical data.	Formal Safety Assessment	Maritime Accidents in the Period 2000–2012	Q2	6,392
8	Kum & Sahin (2015)	SAFETY SCIENCE	Elsevier; Engineering, Industrial	121	The development of crew training manuals, competency standards, and the establishment of Arctic navigation training facilities can all benefit from the findings of this study.	to conduct a root cause analysis investigation into the marine incidents that the Marine Accident Investigation Branch (MAIB) has documented as happening north of 66°33' between the years of 1993 and 2011.	Root Cause Analysis (RCA) and Fuzzy Fault Tree Analysis (FFTA)	Arctic Marine Accidents from 1993 to 2011	Q2	6,392
9	Zhang et al. (2016)	OCEAN ENGINEERING	Elsevier; Engineering, Marine	120	In this study, an improved approach for identifying near misses between ships using AIS data is provided and demonstrated to be effective in decreasing the frequency of near misses requiring additional expert analysis.	to analyzing maritime traffic data for near misses between ships, especially in open water and coastal restricted sea areas.	A new technique based on the principles of the traffic conflict technique	AIS Data from the Northern Baltic Sea	Q1	4,372
10	Fowler et al. (2000)	RISK ANALYSIS	Wiley; Mathematics, Interdisciplinary Applications	119	The Commission of the European Communities (CEC) project “Safety of Shipping in Coastal Waters” (SAFECO) outcomes are presented in this article.	to determine the influences that could increase the safety of shipping in coastal waters.	Marine Accident Risk Calculation System (MARCS)	The case study area is the North Sea area in the Lloyd's Maritime Information System casualty database.	Q1	4,302

The distribution of publications on maritime accidents by country is shown in Figure 3. People’s Republic of China tops the list with 1800 citations, followed by England with 1354 citations, Türkiye with 1274 citations, Finland with 1019 citations, and Norway with 757 citations. People’s Republic of China also possessed the greatest number of documents. South Korea is in the second place in terms of the number of published documents, while it is in the fifth place in the citation ranking.

Also revealed were that Poland had 495 citations with 25 publications, the USA had 398 citations with 24 citations, and France and Sweden had 484 and 462 citations, respectively, with 13 publications each. Of the 196 countries in the world, we noted that just 55 have written papers on the topic. Nonetheless, current findings indicate that “maritime accidents” are a growing field of study in the majority of countries.



**Figure 3.** The distribution of publications cites on maritime accidents by country



**Figure 4.** The most influential journals in the field of maritime accidents







articles written in languages other than English and those published over a wider period of time can be analyzed. Choosing “article” as the only document type is one of the limitations of this study. In future research, the study could be expanded by including additional document types. Furthermore, while the data for the present study were taken from WoS, future research can utilize a variety of bibliometric techniques and additional databases as well. The current study is also limited to using a single database.

The outcomes of this study can help researchers by providing insight on how to conduct their research in terms of journal selection, authors who contributed, research trends, countries, and keywords. Various databases, including scientific collections, might be used as data sources in future studies. In future research, the search can be broadened to include terms such as “incident”.

### Compliance With Ethical Standards

#### Authors' Contributions

AY: Conceptualization, Software, Resources, Investigation, Methodology, Visualization, Formal analysis, Writing – review and editing.

CS: Conceptualization, Writing – review and editing, Resources, Supervision, Investigation, Visualization

#### Conflict of Interest

The authors declare that they have no conflict of interest.

#### Ethical Approval

For this type of study, formal consent is not required.

#### Data Availability Statements

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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