

# Bibliometric and systematic literature review on safety management in the shipping industry and further development in Indonesia

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## ABSTRACT

*This study aims to analyse safety management in the shipping industry and suggest further research. Safety management is a critical component in preventing accidents within the shipping industry. Unfortunately, ship accidents are relatively common. To improve safety management in the shipping industry, it is necessary to identify various problems and solutions from previous studies. This study uses comprehensive mapping, utilising bibliometric and systematic reviews, to analyse 669 articles within the Scopus database. The findings indicate an increase in the number of publications, while the number of citations is decreasing. China is identified as the most influential country in terms of publication numbers and international collaborations. Co-authorship analysis reveals that only 24 out of 1,773 authors collaborated with other authors. Based on the systematic review, this study concludes that the human factor plays a crucial role in the effectiveness of safety management. Therefore, further research focusing on support systems that can reduce human error in safety management is important. Additionally, research on the relationship between cultural and structural aspects in safety management is necessary to reduce friction between the two aspects. This research contributes to the mapping of previous research and can be used to determine the topic of further research.*

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**Key words:** safety management, bibliometric, systematic, risk, accident, literature, Indonesia

## INTRODUCTION

The shipping industry has an important role, both for economy and national defence. In the economic field, the shipping industry is a means of transportation used by various countries, including in international trade. Based on data, 90% of goods shipments use ships as a means of transportation. On the other hand, various countries use ships as a means of transportation and state military defence [1, 2]. Especially for archipelagic countries, the presence of ships and other equipment with various specifications is vital to detect exploitation by other parties. However, the data show that the number of accidents in ship transportation is high. For example, Marine Accident and Incident Reports show that there were 20 accidents

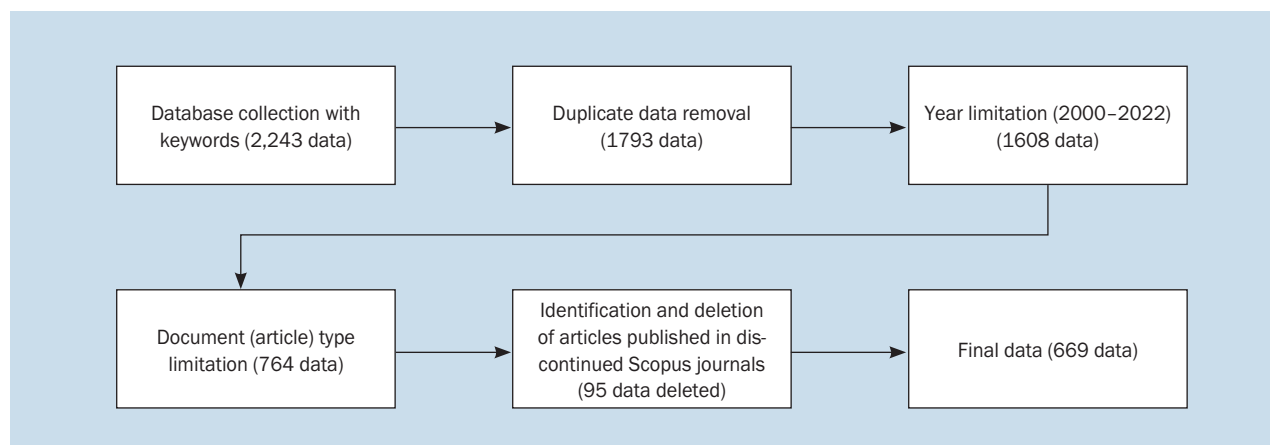
in 2018–2019. This data is only accident data reported by the Japan Transport Safety Board and does not include accidents in other countries. Based on the Transportation Safety Board of Canada, there were 520 maritime accidents during 2014–2021 [3]. Especially in Indonesia, National Transportation Safety Committee (2021) shows that during 2018–2021 there were 483 ship accidents or 120 accidents per year. Thus, safety management in the shipping industry is crucial.

Looking at the above phenomenon, research in the field of safety management is fundamental in finding new solutions to improving safety management. Thus, it is necessary to map the research potential using bibliometric and systematic review to develop the important aspect on the safety

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**Figure 1.** Data selection process. Source: Data processing result, compiled by author

management. Previous research has been conducted by Gil et al. [4], who conducted bibliometric and systematic literature reviews with a focus on policy systems in preventing accidents on ships and linking them to the Technology of Readiness Level, and Fu et al. [5], who conducted a bibliometric and systematic literature review with a focus on risk management in maritime accidents. However, previous studies analysed the literature on particular topics. Thus, a broader literature analysis is needed.

This study analyses the safety management literature in the shipping industry using bibliometric methods and a systematic literature review. Bibliometric Literature Review is used to analyse literature regarding research trends, authors with the most publications, most influential countries, the collaboration of authors, journals with the most publications, and frequently used keywords. A systematic Literature Review analyses comprehensive information on what can be developed in safety management in the shipping industry. The data is sourced from Scopus by entering various keywords. This study sets a limitation year from 2000–2022 to present relevant literature on current conditions. Finally, to conduct a systematic literature review, this study ranks all publications and groups them into several topics for in-depth analysis.

## RESEARCH METHOD

### BIBLIOMETRIC LITERATURE ANALYSIS

This study uses a qualitative approach with a bibliometric literature review to analyse the development of research in the safety management in the shipping industry. This method has been used by previous studies such as Del Giudice et al. [6] to evaluate the literature on digital technology for the sustainability of the shipping business, Gil et al. [4] to evaluate onboard disaster prevention policy systems, and Murnim et al. [7] to evaluate big data in the maritime industry.

The data used were sourced from the Scopus by searching for the keywords “ship” AND “safety management”, “shipping” AND “safety management”, “ship” AND “safety security”, “shipping” AND “safety security”, “ship” AND “safety system”, “shipping” AND “safety system”, “ship” AND “safety law”, “shipping” AND “safety law”, “ship” AND “risk”, “ship” AND “accident”, and “ship” AND “accident” AND “management.” The Scopus was chosen with the consideration that (1) the Scopus index is an index for reputable international journals, and (2) various universities and other institutions use it as an indicator in performance appraisal. In total, there were 2,243 publications with these keywords. Then, the authors conducted various screening processes (Fig. 1).

After the screening process, 669 data from Scopus database will be analysed further. This research used Vos Viewer software and Microsoft Excel to map the data. Vos Viewer was used to visualise the network, while Microsoft Excel was used to tabulate data. Thus, the data analysis included the language used, the number of publications and citations per year, research trend, the most influential country, the most influential author, the journal with the highest number of publications, and frequently used keywords.

### SYSTEMATIC LITERATURE REVIEW

This study also used a systematic literature review, which refers to Gil et al. [4]. This study determined the ranking of published articles based on the most frequent citations. Finally, this research analysed 5% of the articles with the most frequent citations. The article was selected in systematic literature review will be analysed to gather comprehensive information on the safety management in shipping industry and the implications offered to related stakeholders.

## RESULTS AND DISCUSSION

### BIBLIOMETRIC REVIEW ANALYSIS

This study analysed the literature on safety management in the shipping industry from the Scopus database. Considering the sharpness and quality of the literature, this research only analyses “article” type with a total of 669 publications after screening processes, as shown in Figure 1. The articles were mainly written in English, as shown in Table 1. This condition shows that researchers publish more articles in international languages so that they can be read easily. Furthermore, Chinese became the second language used.

Research on safety management in the shipping industry started in the 1980s. However, the researcher limits the literature analysis from 2000–2022 to get relevant research.

**Table 1.** Use of language in article publication

Language	Total publication	Percentage (%)
Chinese	32	0.048
English	624	0.931
French	4	0.006
German	4	0.006
Italian	2	0.003
Portuguese	1	0.001
Russian	1	0.001
Serbian	1	0.001
Croatian	2	0.003
Total	669	100

Source: Data processing result, compiled by author

Based on the number of publications, the trend shows an increase in publications every year, with 2021 being the year of most publications. However, when compared to the total citations, the most numerous citations were in 2013, whereas at that time, there were only 20 articles (Table 2).

This condition indicates that although there is an increasing trend in the number of published articles, this condition differs from the total citation, which shows a decreasing trend. This is an opportunity and challenge for researchers to develop research by paying attention to the relevance and quality of research articles with current and future conditions (Fig. 2).

China has the highest number of articles with 156 publications, followed by the United States and the United Kingdom with 71 and 61 publications. There are several reasons China and the United States have the highest publicity. First, China and the United States are countries with strong militaries [1]. The shipping industry in China and the United States is not only related to economic purposes but also for military and national defence interests. Thus, it is a must to have a high level of safety and good management in shipping industry. Therefore, many things can be researched to produce the highest number of publications (Table 3).

However, the United Kingdom became the country with the most citations. This result can occur because the United Kingdom is one of the countries that has a leading security regime in the offshore sector [8], and also marine is one of the economic assets in the United Kingdom; thus, safety management is important aspect [9]. There is an asymmetry in the number of articles and citations. Thus, further researchers need to improve the quality and relevance of the topics to increase the number of citations.

**Table 2.** Number of publications and citations per year

Year	TP	TC	Year	TP	TC	TAP	TAC
2000	11	295	2012	24	327	669	12135
2001	5	88	2013	20	1051		
2002	13	194	2014	36	1048		
2003	11	69	2015	25	667		
2004	8	57	2016	32	652		
2005	9	143	2017	35	624		
2006	16	576	2018	41	681		
2007	23	671	2019	51	794		
2008	19	498	2020	72	566		
2009	24	920	2021	79	405		
2010	26	1029	2022	65	74		
2011	24	706					

Source: Data processing result, compiled by author; TP – total publications; TC – total citations; TAP – total all publications; TAC – total all citations

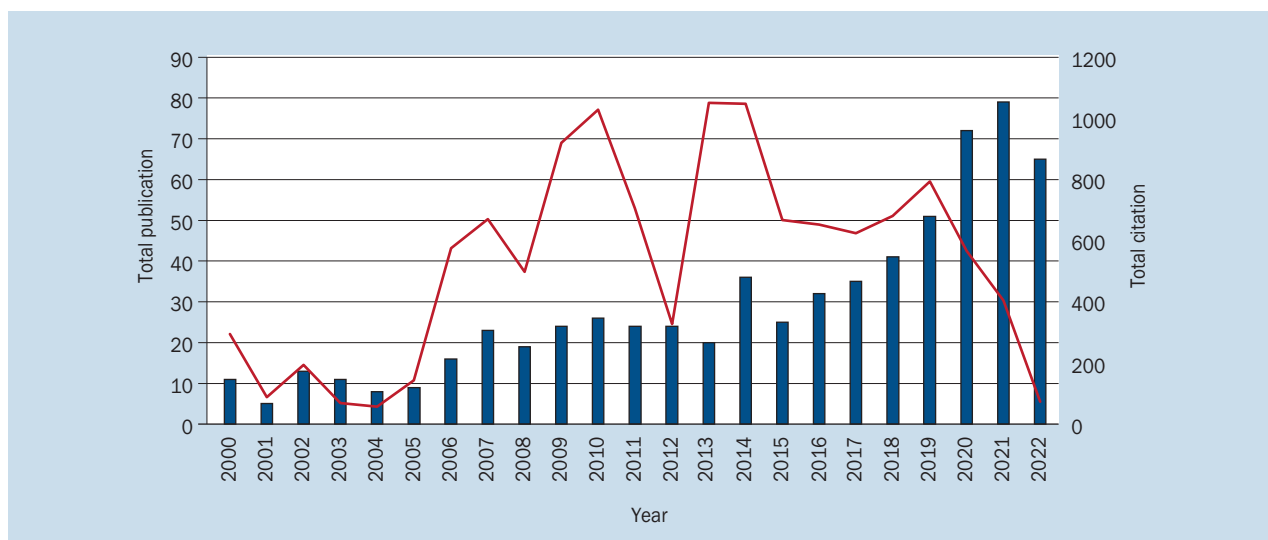


Figure 2. Publication and citation trends per year. Source: Data processing result, compiled by author

Table 3. Countries with the highest number of publications

Countries	TP	TC	TP/TC
China	156	1416	9
United States	71	1032	15
United Kingdom	61	1746	29
Norway	50	1310	26
Turkey	45	1218	27
Finlandia	32	1186	37
Italia	26	664	26
Canada	25	548	22
South Korea	25	162	6
Greece	23	323	14

Source: Data processing result, compiled by author; TP – total publications; TC – total citations

Based on network analysis, researchers from China most collaborated with researchers in other countries, followed by the United States, the United Kingdom, and Norway. This condition shows that researchers need to collaborate with researchers in other countries. This aims to increase insight in article writing and as collaboration in strengthening the urgency of research to be built. In addition, research on safety management in the shipping sector needs to get references from management from other countries to strengthen research (Fig. 3).

This study analyses the number of publications by each author with a minimum of 5 publications. The data shows that Pentti Kujala has the highest number of publications. Moreover, only 24 of 1.773 authors have 5 publications, while other authors only have 1 or 2 publications

in the field of safety management in the shipping industry. This condition shows that there are still limited authors who have a focus on safety management in the shipping industry (Table 4).

This condition is also reflected by the limited collaboration between authors which shows that no network connects all the existing authors (Fig. 4). In addition, many authors publish their articles as a single author. Thus, collaboration between authors is needed to produce articles with better quality, because of the different points of view between authors.

*Safety Science* is the journal that publishes the highest number of articles, with a total of 51 publications, followed by *International Maritime Health*, *Ocean Engineering, Journal of Marine Science and Engineering*, and *Reliability*

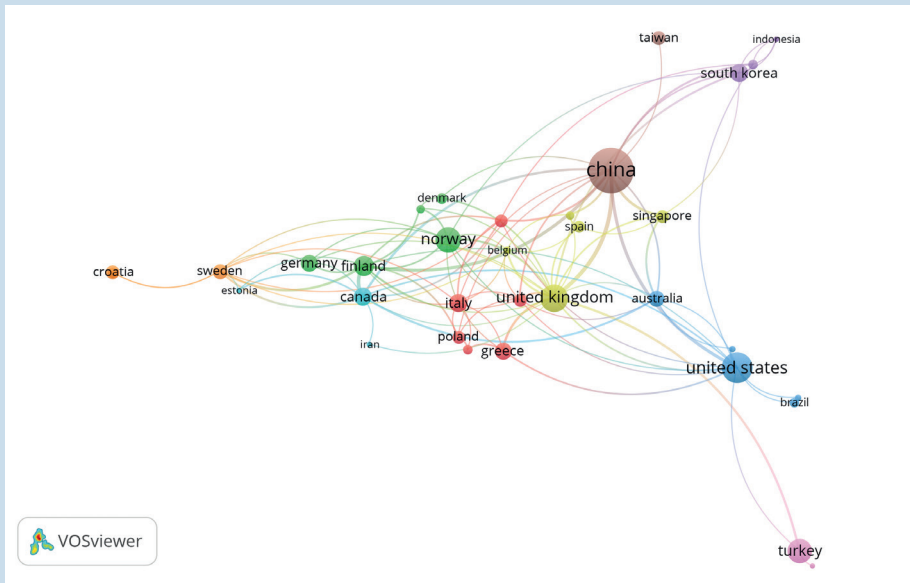


Figure 3. Author collaboration based on country analysis. Source: Data processing result, compiled by author

Table 4. Five authors with the highest number of publications

Author	Affiliation	Countries	TP	TC	H-index
Pentti Kujala	Aalto University	Finlandia	16	829	41
Floris Goerlandft	Dalhousie University	Canada	15	703	35
Metin Celik	Istanbul Teknik University	Turkey	13	771	24
Jin Wang	Liverpool John Moores University	United Kingdom	10	533	56
Shanshan Fu	Shanghai Maritime University	China	9	83	9

Source: Data processing result, compiled by author; TP – total publications; TC – total citations

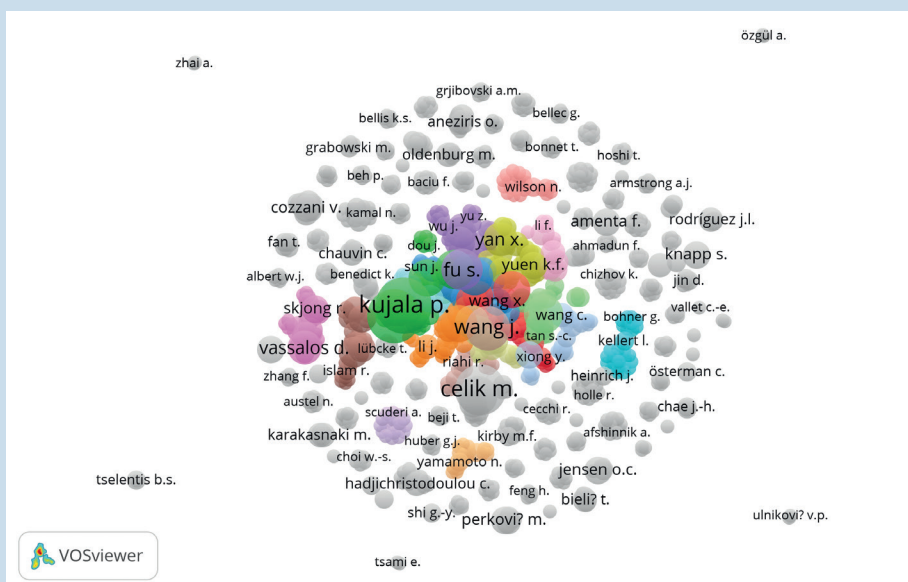


Figure 4. Co-authorship network by number of publications. Source: Data processing result, compiled by author

**Table 5.** Journals with the highest number of publications

Journal	TP	TC	Publisher	Rank	SJR
<i>Safety Science</i>	51	2183	Elsevier	Q1 in "Safety Research", "Safety, Risk, Reliability and Quality", "Public Health, Environmental and Occupational Health", and "Building and Construction"	1.438
<i>International Maritime Health</i>	31	119	Via Medica	Q3 in "General Medicine"	0.245
<i>Ocean Engineering</i>	23	440	Elsevier	Q1 in "Ocean Engineering" and "Environmental Engineering"	1.381
<i>Journal of Marine Science and Engineering</i>	21	82	MDPI	Q2 in "Ocean Engineering" and "Civil and Structural Engineering", and Q3 in "Water Science and Technology"	0.542
<i>Reliability Engineering and System Safety</i>	17	671	Elsevier	Q1 in "Safety, Risk, Reliability and Quality", "Industrial and Manufacturing Engineering"	1.842

Source: Data processing result, compiled by author; TP – total publications; TC – total citations; MDPI – Multidisciplinary Digital Publishing Institute

**Table 6.** Publications with the highest number of citations

Authors	Title	Source title	Total citation
Hetherington et al. [12]	Safety in shipping: The human element	<i>Journal of Safety Research</i>	427
Chauvin et al. [10]	Human and organizational factors in maritime accidents: Analysis of collisions at sea using the HFACS	<i>Accident Analysis and Prevention</i>	310
Harati-Mokhtari et al. [13]	AIS: Data reliability and human error implications	<i>Journal of Navigation</i>	241
Celik and Cebi [11]	Analytical HFACS for investigating human errors in shipping accidents	<i>Accident Analysis and Prevention</i>	211
Akhtar and Utne [14]	Human fatigue's effect on the risk of maritime groundings: A Bayesian network modelling approach	<i>Safety Science</i>	156
Xiao et al. [15]	Comparison study on AIS data of ship traffic behaviour	<i>Ocean Engineering</i>	133
Martins and Maturana [16]	Application of Bayesian belief networks to the human reliability analysis of an oil tanker operation focusing on collision accidents	<i>Reliability Engineering and System Safety</i>	131
Lu and Yang [17]	Safety leadership and safety behaviour in container terminal operations	<i>Safety Science</i>	130
Celik et al. [18]	A risk-based modelling approach to enhance shipping accident investigation	<i>Safety Science</i>	128
Hänninen [19]	Bayesian networks for maritime traffic accident prevention: Benefits and challenges	<i>Accident Analysis and Prevention</i>	125

Source: Data processing result, compiled by author; AIS – automatic identification system; HFACS – Human Factors Analysis and Classification System

*Engineering and System Safety*. This journal is indexed by Scopus Q1–Q3, which shows that the journal publishes quality articles and focuses on research and scientific development about safety research in the shipping industry (Table 5).

Based on the publication with the most frequent citations, 7 out of 10 publications discuss human factors in the safety management as shown by Hetherington et al. [12], Chauvin et al. [10], Harati-Mokhtari et al. [13], Celik and Cebi [11], Akhtar and Utne [14], Martins and Maturana [16], and Lu and Yang [17]. This result is reasonable because 80–85% of ship accidents are caused by human error [13]. The article entitled "Safety in shipping: The human element" by Hetherington et al. [12] is the article with the highest number

of citations. It analysed the literature on safety in three areas: common themes of accidents, the influence of human error, and interventions to make shipping safer. The author emphasizes the importance of monitoring and modifying human factors in improving maritime safety performance. In this regard, the question arises about how effective monitoring of human factors can improve safety management. Thus, future research focusing on these topics can be developed. On the other hand, Chauvin et al. [10] emphasize the importance of Bridge Resource Management and human reliability in dealing with critical situations on board. Harati-Mokhtari et al. [13] argue that automatic identification system (AIS) has the potential to reduce human errors and improve safety management (Table 6) [10–19].



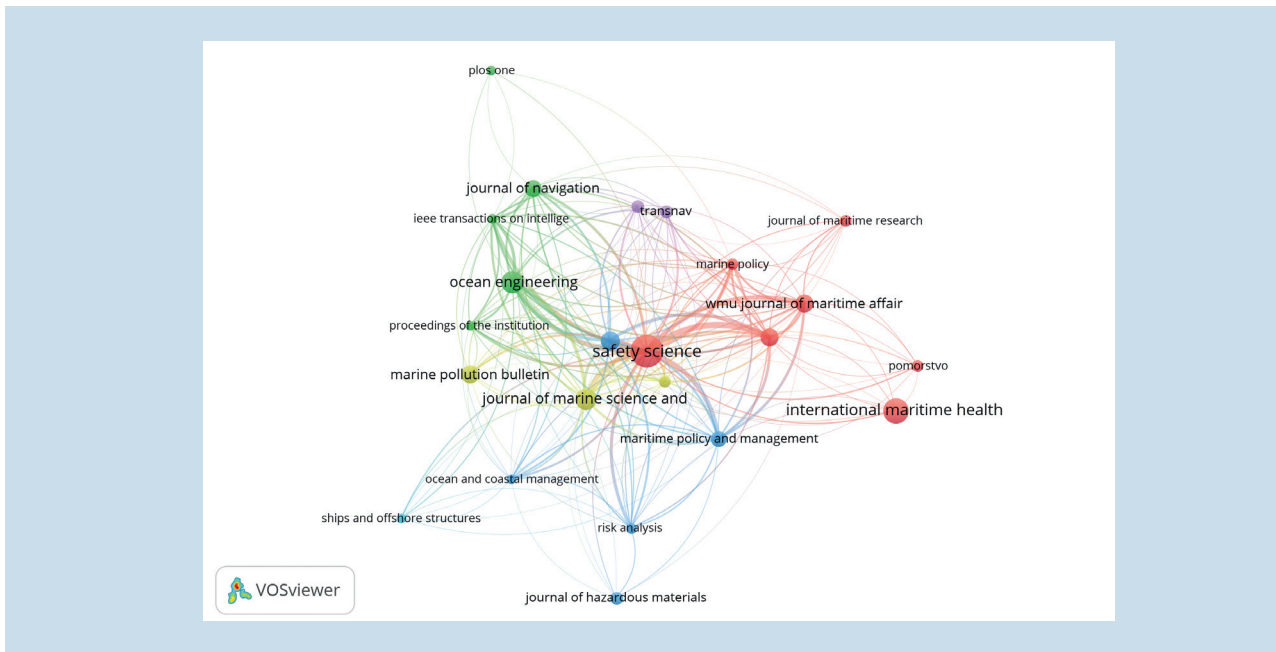


Figure 5. Publication network based on journal analysis. Source: Data processing result, compiled by author

Table 7. Frequently used keywords based on author keyword

Author keyword	Frequency
Maritime safety	33
Safety	29
Safety management	27
Risk assessment	24
Risk management	22
ISM code	21
Human factor	19
Risk analysis	15
Seafarers	15
Safety culture	14

Source: Data processing result, compiled by author

Table 8. Frequently used keywords based on keyword index

Index keyword	Frequency
Ships	280
Article	180
Human	153
Risk assessment	150
Ship	128
Accidents	122
Humans	121
Safety	115
Accident prevention	110
Risk management	88

Source: Data processing result, compiled by author

This study identified the journals that publish the highest number of articles with a minimum of 5 publications. It has been noted that there are 25 journals with a minimum of 5 publications and are divided into 6 network clusters. Based on the Table 6, *Safety Science* is the journal with the highest number of publications (Fig. 5).

Based on the keywords used, this study analysed keywords based on “author keywords” and “index keywords”. This was to show the keywords provided by the author in the original article and keywords from the automatic algorithm that is read from the article’s title cited in a paper. This study analysed keywords with a minimum of 5 publications by each author (Tables 7, 8).

The keyword “maritime safety” is often associated with “safety management”, “ism code”, “risk management”, “risk analysis”, “human factors”, “safety culture” and other topics as shown in Figure 6. Meanwhile, based on the “index keywords”, there are differences in keywords that are often used. The keyword “ships” is often used, which is then followed by “article”, “human”, “risk assessment”, and “ship”.

Safety management also concerns the safety culture that already exists and will be built after various evaluations. Meanwhile, based on the “index keywords”, research in the field of “safety management” in the shipping sector focuses not only on how to manage safety ideally but also





**Table 9.** Systematic review for articles with the most citation

Category	Author	Finding	What can be learned
Human factor	Chauvin et al. [10]	Most crashes are caused by mistakes in decision making	The importance of bridge human resources for pilot navigation situations in confined waters
	Celik and Cebi [11]	This study builds the HFAS mechanism to identify human error factors in ship accidents	Human error is a contributing factor at various levels of the organization
	Hetherington et al. [12]	Accidents on ships caused by individual or organizational behaviour can be moderated and reduced to improve safety	The importance of proper management to address the various human factors that affect safety
	Harati-Mokhtari et al. [13]	The information in AIS is not fully valid because there is manual input which can result in inaccurate information being presented	The need for strict supervision of all information contained in AIS
	Akhtar and Utne [14]	The strongest fatigues associated with top management were ship certification, crew resources, and quality control	Fatigue is a major risk factor
	Martins and Maturana [16]	Methodology based on Bayesian network for analysing human factors on the risk of accidents by collision	The importance of methods to reduce the risk of ship accidents caused by human error
	Schröder et al. [20]	Ship traceability investigators will not examine organizational-sourced factors if the guidelines in the IMO are complied with	The importance of complying with applicable standards and guidelines
	Zhang et al. [21]	Origin-to-destination pairs and navigation routes in Singapore's port waters have remained stable over time	The importance of knowing the various factors that cause accidents that occur in all water conditions
AIS	Lu and Yang [17]	Safety motivation and concern for safety positively influence safety behaviour	Improve safety in container terminal operations
	Harati-Mokhtari et al. [13]	The information in AIS is not fully valid because there is manual input which can result in inaccurate information being presented	The need for strict supervision of all information contained in AIS
	Xiao et al. [15]	There are similarities and differences in the characteristics of AIS analysis in the Dutch Case and Chinese Case that affect ship traffic behaviour	This study only examines direct information, without indirect information on AIS
	Zhang et al. [21]	Origin-to-destination pairs and navigation routes in Singapore's port waters have remained stable over time	The importance of knowing the various factors that cause accidents that occur in all water conditions
Accident	Kao et al. [22]	Precise prediction of collision time and position can be achieved using the GIS spatial analysis module	The importance of predicting the right information to avoid accidents
	Hassel et al. [23]	50% of accidents go unreported	Users of ship accident statistics must apply certain standards to analyse inadequate reporting, as well as to produce appropriate analysis
	Lu and Tsai [24]	The dimensions of work safety have the most important influence on ship accidents	There are many factors to consider in safety management
	Kirby and Law [25]	Risk, impact and mitigation in accidents at sea	The importance of an impact assessment and monitoring program after an accident
	Psarros et al. [26]	There are incomplete reports of accidents	It is important to fully report accident data
	Akyuz [27]	Accident analysis model with HFACS with ANP integration	The importance of various models in accident analysis
	Hänninen [19]	Bayesian network is a fairly precise tool for maritime safety management and decision making	The importance of standards or models in safety management



**Table 9. (cont.)** Systematic review for articles with the most citation

Category	Author	Finding	What can be learned
Risk analysis	Akhtar and Utne [14]	The strongest fatigues associated with top management were ship certification, crew resources, and quality control	Fatigue is a major risk factor
	Celik et al. [18]	Integration of FFTA into SAI to ensure database consistency for accident analysis and prevention efforts in the maritime industry	It is important to investigate the occurrence of accidents on ships as a precautionary measure
	Zhang et al. [21]	Origin-to-destination pairs and navigation routes in Singapore's port waters have remained stable over time	The importance of knowing the various factors that cause accidents that occur in all water conditions
	Goerlandt et al. [28]	Development of fundamental issues on the concept of risk in the Collision Alert System	The importance of analysing risks in the shipping industry
	Bonvicini and Spadoni [29]	New methodology for selecting the best route for transportation based on risk analysis	The importance of determining ship transportation traffic routes to prevent collisions
	Khan and Khan [30]	Building an object-oriented Bayesian network model for accident prevention in icy waters	The importance of developing a maritime traffic strategy especially in extreme climates
	Banda et al. [31]	Navigation in icy waters is more complex and is the type of navigation with the highest reported accidents	The importance of analysing risks especially in extreme climates
	Kirby and Law [25]	Risk, impact and mitigation in accidents at sea	The importance of an impact assessment and monitoring programme after an accident
	Cicek and Celik [32]	Adaptation of marine technology that is integrated with operational aspects to prevent ship explosion failures	The importance of innovation in improving machine system reliability and operational safety
	Lu and Yang [33]	The dimensions of work safety have the most important influence on ship accidents	It is important to improve the safety of ship operations
Culture	Antonsen [34]	A lot of friction between the cultural aspect and the structural aspect	Need synchronisation between management and culture to improve safety on ships

Source: Data processing result, compiled by author; AIS – Automatic Identification System; ANP – Analytical Network Process; HFACS – Human Factors Analysis and Classification System; FFTA – Fuzzy Extended Fault Tree Analysis; GIS – Geographic Information System; SAI – Shipping Accident Investigation; IMO – International Maritime Organization

a potential for researchers to develop research in the field of safety management in Indonesia. Based on the author's identification using advanced data from the Scopus database totalling 160 data with the keywords "ship" and "maritime" processed through the Vos Viewer, it was shown that Indonesian researchers are more interested in discussing "automatic identification systems (AIS)", "computation fluid dynamics", and "illegal fishing" rather than safety management. Activation of AIS on ships is also one of the safety standards in the Safety of Life at Sea (SOLAS) so that traffic in the ocean is not disturbed. AIS activation in Indonesia is essential because of the many cases of illegal ships entering Indonesian waters. However, safety management does not only cover AIS but also includes other factors such as human error [9–11]. Thus, the development of research in the field of safety management in Indonesia is important.

## RESEARCH IMPLICATION

This research has theoretical and practical implications. Theoretically, using a bibliometric review, this study

analyses the extent to which the literature on safety management and topics that researchers widely discuss include keywords that researchers often use. This mapping makes it easier for future researchers to fill the research gap. The results of this study indicate that there are several publications in the field of safety management. However, the number of publications is separate from the trend in the number of citations. Thus, researchers must focus on the published articles' quality and quantity.

In addition, this study also uses a systematic review method to provide recommendations for further research from the results of a systematic analysis of articles with the highest number of citations. The existence of an analysis related to the lessons taken from the article makes it easier for stakeholders, both government and practitioners in the shipping industry, to make decisions to improve the effectiveness of safety management, in the shipping industry, including the shipping industry in Indonesia. The proposals for the following research topic can be seen in Table 10.

**Table 10.** Proposed next research

No.	Theme	Research topic
1	Mapping	Analysis of systematic literature review of safety management topics using the Web of Science database
2	Experiment	Comparison of the cost and benefit of the shipping industry between those who implement safety management and those who do not
3	Behaviour	Factors causing low safety management
4	Human factor	Factors of human error and the potential for accidents
5	Accident	Accident prediction model
6	Risk analysis	Ship industry risk analysis model
7	Culture	The cultural differences of each shipping industry around the world
8	Management	Shipping Industry management model with benefit, opportunity, cost, and risk approach
9	Accounting	Cost accounting for safety management and its impact on the shipping industry

Source: Data processing result, compiled by author

## CONCLUSIONS

This study used a bibliometric method to analyse the development of “safety management” in the shipping industry by reviewing articles published in Scopus-indexed journals. This study provided information related to the language used, the number of publications and citations each year, the trend of publications and citations, the country with the highest number of publications, the author with the highest number of publications, the journal with the highest number of publications, and frequently used keywords based on the “author keyword” and “index keywords”.

Research on safety management has become an exciting topic, especially the developments in the shipping industry carried out by governments in various countries. Trend analysis shows an increase in the number of articles published annually, with 2021 being the year with the highest number of publications. However, this condition is inversely proportional to the number of citations, which shows a decreasing trend. China has the most significant number of publications with many collaborations. On the other hand, the analysis of co-authorship shows that only 24 out of 1,773 collaborated with other authors, while others were single authors. This condition shows the importance of collaboration between researchers in developing research. In addition, we conclude that human factors are the most important factor in increasing safety management in the shipping industry.

The novelty of this research lies in the broader use of safety management topics. In contrast, previous research has focused more on specific topics, namely maritime accidents and the level of technological readiness in preventing accidents on ships. In addition, to identify the most cited topics, this study uses a systematic literature review method to identify findings and lessons that stakeholders can draw. Based on the systematic review, further research can focus

on each country’s “culture” of safety management by analysing the relationship between culture and human factors and risk analysis. In developing research in Indonesia, this research emphasizes the importance of research on safety management, especially in human factors and risk analysis.

This study has limitations. First, this research only analyses data from the Scopus database with the type of “article” document and does not analyse the type of book, proceeding, and so on. Therefore, further research can develop research by multiplying the databases used, such as the Web of Sciences, Sinta Index, and other indexations, to increase the amount of data to be analysed. Second, this research also focuses on further development in Indonesia so that further research can use a bibliometric and systematic review by focusing on safety management in each country.

**Conflict of interest:** None declared

## REFERENCES

- Chen H, An M, Wang Q, et al. Military executives and corporate environmental information disclosure: Evidence from China. *J Clean Prod.* 2021; 278: 123404, doi: [10.1016/j.jclepro.2020.123404](https://doi.org/10.1016/j.jclepro.2020.123404).
- Erdağ R. Security environment and military spending of Turkey in the 2000s. *Contemp Rev Middle East.* 2020; 8(1): 120–139, doi: [10.1177/2347798920976294](https://doi.org/10.1177/2347798920976294).
- Panagiotidis P, Giannakis K, Angelopoulos N, et al. Shipping accidents dataset: data-driven directions for assessing accident’s impact and improving safety onboard. *Data.* 2021; 6(12): 129, doi: [10.3390/data6120129](https://doi.org/10.3390/data6120129).
- Gil M, Wróbel K, Montewka J, et al. A bibliometric analysis and systematic review of shipboard Decision Support Systems for accident prevention. *Safety Science.* 2020; 128: 104717, doi: [10.1016/j.ssci.2020.104717](https://doi.org/10.1016/j.ssci.2020.104717).
- Fu S, Goerlandt F, Xi Y. Arctic shipping risk management: A bibliometric analysis and a systematic review of risk influencing factors of navigational accidents. *Safety Science.* 2021; 139: 105254, doi: [10.1016/j.ssci.2021.105254](https://doi.org/10.1016/j.ssci.2021.105254).

6. Del Giudice M, Di Vaio A, Hassan R, et al. Digitalization and new technologies for sustainable business models at the ship–port interface: a bibliometric analysis. *Marit Policy Manag.* 2021; 49(3): 410–446, doi: [10.1080/03088839.2021.1903600](https://doi.org/10.1080/03088839.2021.1903600).
7. Munim Z, Dushenko M, Jimenez V, et al. Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions. *Marit Policy Manag.* 2020; 47(5): 577–597, doi: [10.1080/03088839.2020.1788731](https://doi.org/10.1080/03088839.2020.1788731).
8. Acheampong T, Akumperigya R. Offshore risk regulation: A comparative analysis of regulatory framework in Ghana, the United Kingdom and Norway. *Energy Policy.* 2018; 113: 701–710, doi: [10.1016/j.enpol.2017.10.009](https://doi.org/10.1016/j.enpol.2017.10.009).
9. Stebbings E, Papathanasopoulou E, Hooper T, et al. The marine economy of the United Kingdom. *Marine Policy.* 2020; 116: 103905, doi: [10.1016/j.marpol.2020.103905](https://doi.org/10.1016/j.marpol.2020.103905).
10. Chauvin C, Lardjane S, Morel G, et al. Human and organisational factors in maritime accidents: analysis of collisions at sea using the HFACS. *Accid Anal Prev.* 2013; 59: 26–37, doi: [10.1016/j.aap.2013.05.006](https://doi.org/10.1016/j.aap.2013.05.006), indexed in Pubmed: [23764875](https://pubmed.ncbi.nlm.nih.gov/23764875/).
11. Celik M, Cebi S. Analytical HFACS for investigating human errors in shipping accidents. *Accid Anal Prev.* 2009; 41(1): 66–75, doi: [10.1016/j.aap.2008.09.004](https://doi.org/10.1016/j.aap.2008.09.004), indexed in Pubmed: [19114139](https://pubmed.ncbi.nlm.nih.gov/19114139/).
12. Hetherington C, Flin R, Mearns K. Safety in shipping: the human element. *J Safety Res.* 2006; 37(4): 401–411, doi: [10.1016/j.jsr.2006.04.007](https://doi.org/10.1016/j.jsr.2006.04.007), indexed in Pubmed: [17046789](https://pubmed.ncbi.nlm.nih.gov/17046789/).
13. Harati-Mokhtari A, Wall A, Brooks P, et al. Automatic identification system (AIS): data reliability and human error implications. *J Navig.* 2007; 60(3): 373–389, doi: [10.1017/s0373463307004298](https://doi.org/10.1017/s0373463307004298).
14. Akhtar M, Utne I. Human fatigue's effect on the risk of maritime groundings: A Bayesian Network modeling approach. *Safety Science.* 2014; 62: 427–440, doi: [10.1016/j.ssci.2013.10.002](https://doi.org/10.1016/j.ssci.2013.10.002).
15. Xiao F, Ligteringen H, Gulijk Cv, et al. Comparison study on AIS data of ship traffic behavior. *Ocean Engineering.* 2015; 95: 84–93, doi: [10.1016/j.oceaneng.2014.11.020](https://doi.org/10.1016/j.oceaneng.2014.11.020).
16. Martins M, Maturana M. Application of Bayesian Belief networks to the human reliability analysis of an oil tanker operation focusing on collision accidents. *Reliab Eng Syst Saf.* 2013; 110: 89–109, doi: [10.1016/j.res.2012.09.008](https://doi.org/10.1016/j.res.2012.09.008).
17. Lu CS, Yang CS. Safety leadership and safety behavior in container terminal operations. *Safety Science.* 2010; 48(2): 123–134, doi: [10.1016/j.ssci.2009.05.003](https://doi.org/10.1016/j.ssci.2009.05.003).
18. Celik M, Lavasani S, Wang J. A risk-based modelling approach to enhance shipping accident investigation. *Safety Science.* 2010; 48(1): 18–27, doi: [10.1016/j.ssci.2009.04.007](https://doi.org/10.1016/j.ssci.2009.04.007).
19. Hänninen M. Bayesian networks for maritime traffic accident prevention: benefits and challenges. *Accid Anal Prev.* 2014; 73: 305–312, doi: [10.1016/j.aap.2014.09.017](https://doi.org/10.1016/j.aap.2014.09.017), indexed in Pubmed: [25269098](https://pubmed.ncbi.nlm.nih.gov/25269098/).
20. Schröder-Hinrichs JU, Baldauf M, Ghirxi KT. Accident investigation reporting deficiencies related to organizational factors in machinery space fires and explosions. *Accid Anal Prev.* 2011; 43(3): 1187–1196, doi: [10.1016/j.aap.2010.12.033](https://doi.org/10.1016/j.aap.2010.12.033), indexed in Pubmed: [21376918](https://pubmed.ncbi.nlm.nih.gov/21376918/).
21. Zhang M, Zhang Di, Goerlandt F, et al. Use of HFACS and fault tree model for collision risk factors analysis of icebreaker assistance in ice-covered waters. *Safety Science.* 2019; 111: 128–143, doi: [10.1016/j.ssci.2018.07.002](https://doi.org/10.1016/j.ssci.2018.07.002).
22. Kao SL, Lee KT, Chang KY, et al. A fuzzy logic method for collision avoidance in vessel traffic service. *J Navig.* 2006; 60(1): 17–31, doi: [10.1017/s0373463307003980](https://doi.org/10.1017/s0373463307003980).
23. Hassel M, Asbjørnslett BE, Hole LP. Underreporting of maritime accidents to vessel accident databases. *Accid Anal Prev.* 2011; 43(6): 2053–2063, doi: [10.1016/j.aap.2011.05.027](https://doi.org/10.1016/j.aap.2011.05.027), indexed in Pubmed: [21819835](https://pubmed.ncbi.nlm.nih.gov/21819835/).
24. Lu CS, Tsai CL. The effect of safety climate on seafarers' safety behaviors in container shipping. *Accid Anal Prev.* 2010; 42(6): 1999–2006, doi: [10.1016/j.aap.2010.06.008](https://doi.org/10.1016/j.aap.2010.06.008), indexed in Pubmed: [20728654](https://pubmed.ncbi.nlm.nih.gov/20728654/).
25. Kirby MF, Law RJ. Accidental spills at sea: risk, impact, mitigation and the need for co-ordinated post-incident monitoring. *Mar Pollut Bull.* 2010; 60(6): 797–803, doi: [10.1016/j.marpolbul.2010.03.015](https://doi.org/10.1016/j.marpolbul.2010.03.015), indexed in Pubmed: [20381098](https://pubmed.ncbi.nlm.nih.gov/20381098/).
26. Psarros G, Skjong R, Eide MS. Under-reporting of maritime accidents. *Accid Anal Prev.* 2010; 42(2): 619–625, doi: [10.1016/j.aap.2009.10.008](https://doi.org/10.1016/j.aap.2009.10.008), indexed in Pubmed: [20159087](https://pubmed.ncbi.nlm.nih.gov/20159087/).
27. Akyuz E. A marine accident analysing model to evaluate potential operational causes in cargo ships. *Safety Science.* 2017; 92: 17–25, doi: [10.1016/j.ssci.2016.09.010](https://doi.org/10.1016/j.ssci.2016.09.010).
28. Goerlandt F, Montewka J, Kuzmin V, et al. A risk-informed ship collision alert system: Framework and application. *Safety Science.* 2015; 77: 182–204, doi: [10.1016/j.ssci.2015.03.015](https://doi.org/10.1016/j.ssci.2015.03.015).
29. Leonelli P, Bonvicini S, Spadoni G. Hazardous materials transportation: a risk-analysis-based routing methodology. *J Hazard Mater.* 2000; 71(1-3): 283–300, doi: [10.1016/s0304-3894\(99\)00084-9](https://doi.org/10.1016/s0304-3894(99)00084-9), indexed in Pubmed: [10677666](https://pubmed.ncbi.nlm.nih.gov/10677666/).
30. Khan MA, Khan S. Inflation and the economic growth: evidence from five Asian countries. *Pakistan J Appl Econ.* 2018; 28(2): 235–252.
31. Valdez Banda OA, Goerlandt F, Montewka J, et al. A risk analysis of winter navigation in Finnish sea areas. *Accid Anal Prev.* 2015; 79: 100–116, doi: [10.1016/j.aap.2015.03.024](https://doi.org/10.1016/j.aap.2015.03.024), indexed in Pubmed: [25819212](https://pubmed.ncbi.nlm.nih.gov/25819212/).
32. Cicek K, Celik M. Application of failure modes and effects analysis to main engine crankcase explosion failure on-board ship. *Safety Science.* 2013; 51(1): 6–10, doi: [10.1016/j.ssci.2012.06.003](https://doi.org/10.1016/j.ssci.2012.06.003).
33. Lu CS, Yang CS. Safety climate and safety behavior in the passenger ferry context. *Accid Anal Prev.* 2011; 43(1): 329–341, doi: [10.1016/j.aap.2010.09.001](https://doi.org/10.1016/j.aap.2010.09.001), indexed in Pubmed: [21094331](https://pubmed.ncbi.nlm.nih.gov/21094331/).
34. Antonsen S. The relationship between culture and safety on offshore supply vessels. *Safety Science.* 2009; 47(8): 1118–1128, doi: [10.1016/j.ssci.2008.12.006](https://doi.org/10.1016/j.ssci.2008.12.006).