

A Research on Concept of Ship Safety Domain

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ABSTRACT: This study presents the results of the content analysis of articles related to "Ship Safety Domain". The content and statistical analysis of 44 articles that published in 21 different journals between 1970 and 2016 were conducted. This study includes various data types such as publishing years of articles, obtaining the type of data, the contribution of authors, the contribution of countries, the contribution of the institution, the rank of the journal, keywords of articles and etc. The content analysis aims to provide necessary indicators for readers, followers, and contributors of relevant discipline and a glimpse of lots of articles. The published articles about ship safety domain are discovered by this study so as to contribute lecturers and researchers interested in navigation especially ship domain concept. The results of the research were revealed that Poland and China are the most contributing countries, Dalian Maritime University and The Maritime University of Szczecin are the most contributing institutions and Ning Wang and Rafal Szlapczynski are the most contributing researchers.

1 INTRODUCTION

Safety is a basic priority of waterway transportation (Liu et al, 2016). The determination of clear area around the ship is mainly important for safe navigation (Wang and Chin, 2015). Safe navigation is an ever-growing issue, especially due to the rapidly increasing numbers of ships, and improving maritime industry. Even though statistics display developed levels of safety in the industry, which carries 90% of the world trade, the risk of navigational incidents remains a major concern and priority (Baldauf et al., 2015).

The concept of collision avoidance helps to eliminate these risks. It is important the analysis of ship collision risk, probability of occurrence, the understanding of collision probability and possible results of collisions (Tang et al., 2013). Making collision risk assessment is the main issue in the

decision systems, and it is a major concept in navigation (Xu and Wang, 2014). A research prepared by the Nautical Institute (NI) demonstrated that 60% of collision and grounding cases are caused by direct human error (Gale and Patraiko, 2007) on the other hand, the statistics show that human errors have caused 80% of marine incidents for which the basic reason is improper determinations of the navigational case and the result incorrect decisions (Wang et al., 2009). The two major human involved causes are "inadequate determination of the situation" (24%) and "ineffectual look out" (23%) navigation (Wang and Chin, 2015).

Most of the ship domain models are defined in a geometrical manner which is easy to grasp however not conducive for application to practices or simulations. Therefore, there is a need for a uniform analytical framework to describe ship domain models

in order that these models could play a powerful role in marine traffic engineering (Wang et al., 2009).

During the ship navigation, the safety zone is referred as the ship domain. Any infringing of the ship domain is evaluated as a danger to navigational safety (Pietrzykowski and Uriasz, 2009). A ship domain is commonly thought as the space around the ship, which the OOW (Officer of the Watch) wants to keep clear of other objects. (Szlapczynski and Szlapczynska, 2015). Ship domains are powerful and primary accesses to dealing with ship navigation risk determination, with collision avoidance, with marine traffic simulations and with optimal trajectory, etc. Many researchers have submitted ship domains type with various dimensions and shapes in the past decades (Wang, 2013). Ship domain capacity (shape and size) generally depends on ship's speed and length although parameters of other ships may also be considered (Szlapczynski and Szlapczynska, 2015).

The concept of ship domain is crucial for safety navigation so, in this context, the aim of this study is to make a content analysis of articles related to ship safety domain in related literature to guide the academicians and researchers study in the related field.

2 A CONCEPT OF SHIP DOMAIN

Various ship domains have been presented by many researchers having taken into account different shapes and sizes. The determination of ship domains strongly depends on the statistical data and operator experience. It is found that the ship domains described by geometrical figures including ellipse, polygon, circle and other complex figures rather than analytical manner. The circular ship domain proposed by Goodwin (1975) which is divided into three sectors. The model is also obtained from statistical methods from a great number of records and simulator data. The other type of ship domain called as elliptical ship domain is proposed by Fuji and Tanaka (1971). The domain is created by using statistical methods. Coldwell (1983) proposed another elliptical ship domain by similar statistical methods for head on and overtaking situations. Polygonal ship domain proposed by Pietrzykowski (2004, 2006) is also another important type of ship domain. The domain depends on the determination of dynamic functions of ship dimensions and speed (Wang et al., 2009).

3 METHODOLOGY

In this study, 44 articles that were published in various journals between 1970 and 2016, were performed to make a content analysis. This analysis was separated into various categories such as the contributing of authors, the rank of the journal, keywords of articles and etc. When applying statistical analysis, computer-assisted Statistical Package for the Social Sciences (SPSS) software was utilized.

A content and statistical analysis were adopted for 44 articles based on ship safety domain. First of all, we determined categories as authors, countries, institutions, journals, keywords, words in the articles names and years to apply analysis.

The basic aim of this study is to guide researchers who will study about ship safety domain and assist further studies that will be utilized in the ship safety domain research area.

4 FINDINGS

4.1 Authors statistics

Articles in the related field prepared by commonly double and more authors. As seen in Figure 1 and Table 1, 18,2% of articles prepared by double authors and 40,9% of articles prepared by multiple authors.

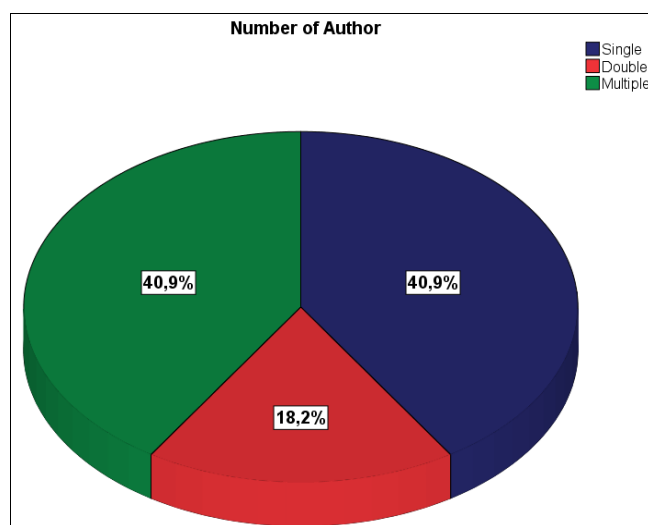


Figure 1. Distribution of the articles according to authors group.

Table 1. The number of authors in articles.

The Number of Authors in Articles	(f)	(%)	C (%)
Single	18	40,9	40,9
Double	8	18,2	69,1
Multiple	18	40,9	100,0
Total	44	100,0	

Table 2. The most contributing authors.

Author	Rank	(f)	(%)	C(%)
Ning Wang	1	6	5,8	5,8
Rafal Szlapczynski	2	5	4,8	10,6
Zbigniew Pietrzykowski	3	4	3,8	14,4
Krzysztof Marczan	4	3	2,9	17,3
Feng Zhou	5	2	1,9	19,2
Jingxian Liu	6	2	1,9	21,2
Lucjan Gucma	7	2	1,9	23,1
Miroslaw Wielgosz	8	2	1,9	25,0
Paul Vernon Davis	9	2	1,9	26,9
Q.Y. Hu	10	2	1,9	28,8
Others	74	7	1,2	100,0
Total		80	104	100,0

The most contributing ten authors are listed in Table 2 and Figure 2. 'Ning Wang' is the most contributing author within a total of 80 authors with 6 articles. Followed by Rafal Szlapczynski with 5 articles and Zbigniew Pietrzykowski with 4 articles.

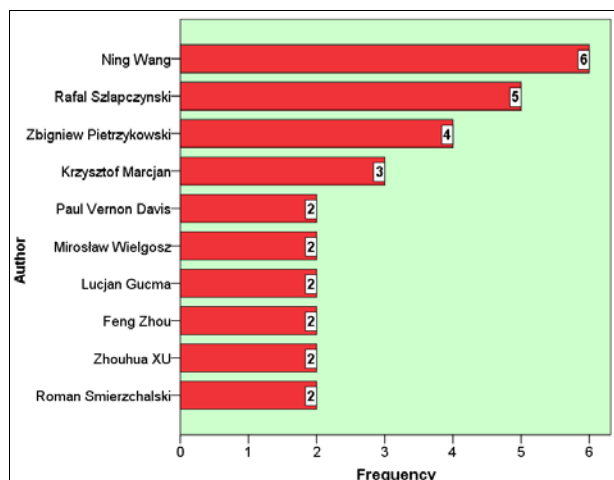


Figure 2. The most contributing authors.

4.2 Bibliometric statistics

A total of 44 selected articles were published in 21 different journals. "The Journal of Navigation" is the most contributing journal with a total of 17 articles.

Table 3. The most contributing journals.

Journal	Rank	(f)	(%)	C(%)
The Journal of Navigation	1	17	38,6	38,6
Journal of Dalian Maritime University	2	3	6,8	54,5
Ship & Ocean Engineering	3	2	4,5	65,9
Activities in Navigation	4	1	2,3	68,2
Annual of Navigation	5	1	2,3	70,5
Information Processing and Security Systems	6	1	2,3	75,0
Journal of Wuhan University of Technology	7	1	2,3	77,3
Missing value		1	2,3	79,6
Others		17	38,6	100
Total		21	44	100

All articles are separated according to 5-years period to simplify cluster. According to analysis results, Studies in related field showed a rapid increase since 2000. While a total number of studies that published between 1970-2000 is equal to 6, 35 articles were published after 2000. The most contributing period is 2011-2016 with the total of 24 studies. On the other hand, no studies have been conducted between 1991 and 1995. Following the recession, a large increase was observed.

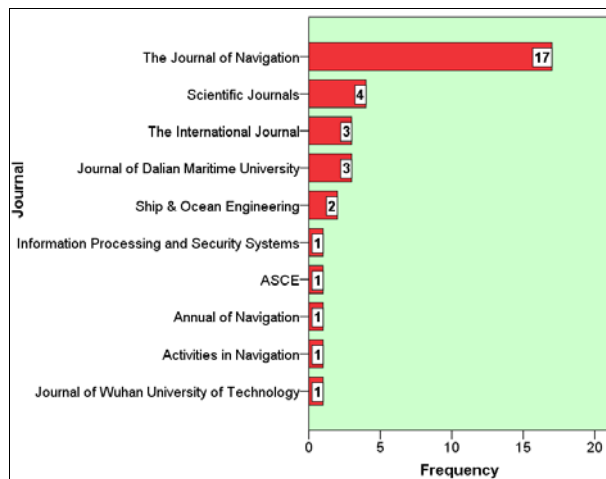


Figure 3. The most contributing journals.

Table 4. Distribution of articles (5-year period).

Year	(f)	(%)	C(%)
1970-1975	1	2,2	2,2
1976-1980	1	2,2	4,4
1981-1985	1	2,2	6,7
1986-1990	1	2,2	8,9
1991-1995	0	0,0	8,9
1996-2000	2	4,4	13,3
2001-2005	3	6,7	20,0
2006-2010	11	26,7	46,7
2011-2016	24	53,3	100,0
Total	44	100	

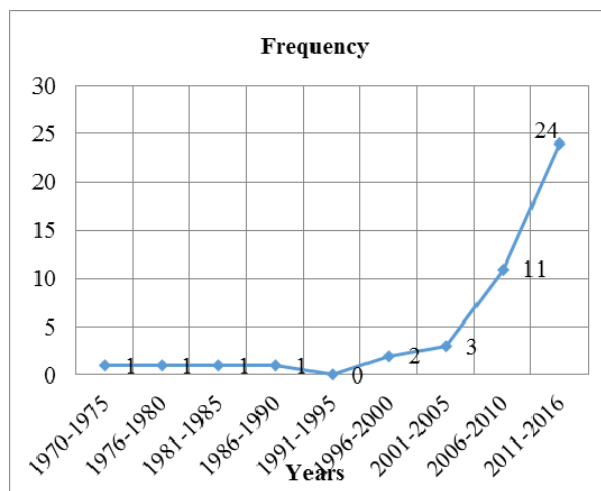


Figure 4. Distribution of articles (5-year period).

4.3 Affiliation statistics

Geographical locations of contributing institutions are shown in Figure 5. The most contributing institutions are in China and Poland. Dalian Maritime University is the most contributing institution followed by Maritime University of Szczecin. Both of them accounted for 34,1% of all articles.

China is the most contributing country with the total of 17 articles and approximately half of them were conducted by Dalian Maritime University. Followed by Poland with the total of 16 articles and approximately one third of them were realized by the Maritime University of Szczecin. China and Poland accounted for 75% of all countries.

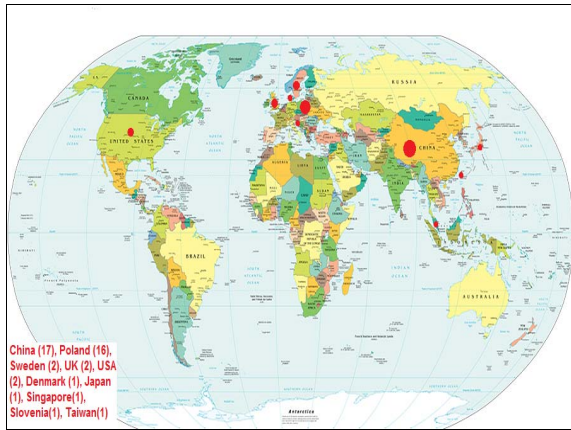


Figure 5. The geographical distribution of contributing countries.

Table 5. The most contributing institutions.

Country	Rank	(f)	(%)	C(%)
China	1	17	38,6	38,6
Poland	2	16	36,4	75,0
Sweden	3	2	4,5	79,5
UK	4	2	4,5	84,1
USA	5	2	4,5	88,6
Denmark	6	1	2,3	90,9
Japan	7	1	2,3	93,2
Singapore	8	1	2,3	95,5
Slovenia	9	1	2,3	97,7
Taiwan	10	1	2,3	100,0
Total	10	44	100,0	

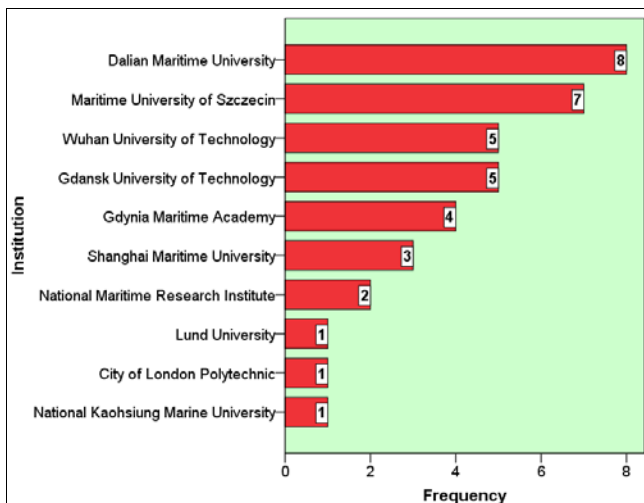


Figure 6. The most contributing institutions.

Table 6. The most contributing countries.

Institution	Rank	(f)	(%)	C(%)
Dalian Maritime University	1	8	18,2	18,2
Maritime University of Szczecin	2	7	15,9	34,1
Wuhan University of Technology	3	5	11,4	45,5
Gdansk University of Technology	4	5	11,4	56,8
Gdynia Maritime Academy	5	4	9,1	65,9
Shanghai Maritime University	6	3	6,8	72,7
National Maritime Research Institute	7	2	4,5	77,3
World Maritime University	8	1	2,3	79,5
National University of Singapore	9	1	2,3	81,8
National Kaohsiung Maritime University	10	1	2,3	84,1
Missing Value		1	2,3	86,4
Others		6	13,6	100,0
Total		17	44	100,0

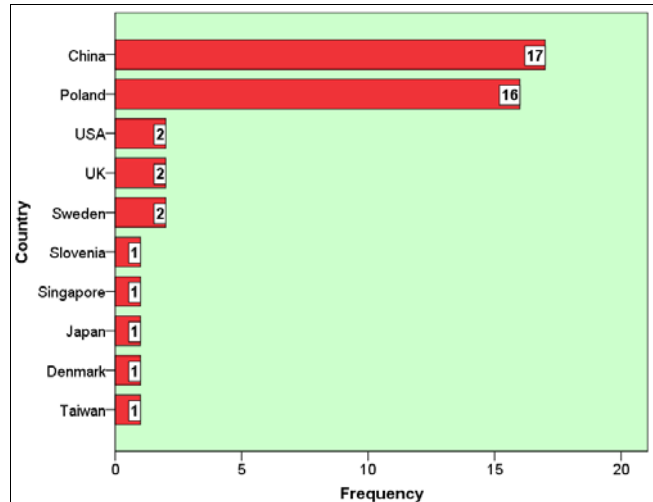


Figure 7. The most contributing countries.

4.4 Keyword statistics

The words used in article titles are analyzed in order to reveal the most used words. 'Domain' (37) and 'Ship' (34) are revealed as the most utilized words as shown in Table 7. and Figure 8. According to keywords analysis, 'Collision avoidance' (8) and 'ship domain' (7) is the most used keywords within 70 keywords as shown in Table 8. and Figure 9.

Table 7. The words used in article titles.

The words in the article titles	Rank	(f)	(%)	C(%)
Domain	1	37	11,6	11,6
Ship	2	34	10,7	22,3
Collision	3	12	3,8	26,0
Area	4	9	2,8	28,8
Safety	5	9	2,8	31,7
Model	6	8	2,5	34,2
Risk	7	7	2,2	36,4
Based	8	6	1,9	38,2
Water	9	6	1,9	40,1
Assessment	10	5	1,6	41,7
Others		286	58,3	100,0
Total		133	319	100,0

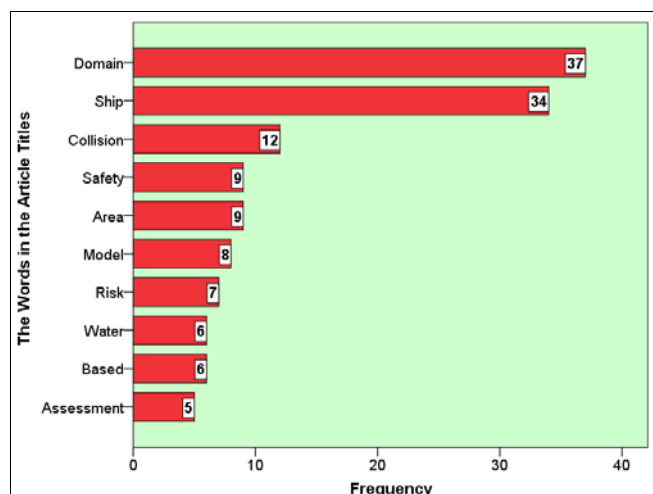


Figure 8. The words used in article titles.

Table 8. The keywords used in article.

Keywords	Rank	(f)	(%)	C%
Collision avoidance	1	8	9,3	9,3
Ship domain	2	7	8,1	17,4
Collision risk	3	3	3,5	20,9
Restricted area	4	2	2,3	23,3
DCPA	5	1	1,2	24,4
3D Model	6	1	1,2	25,6
Accident prevention	7	1	1,2	26,7
AIS data	8	1	1,2	27,9
Analytical model	9	1	1,2	29,1
Approach parameters	10	1	1,2	30,2
Others		60	69,8	100,0
Total		70	86	100

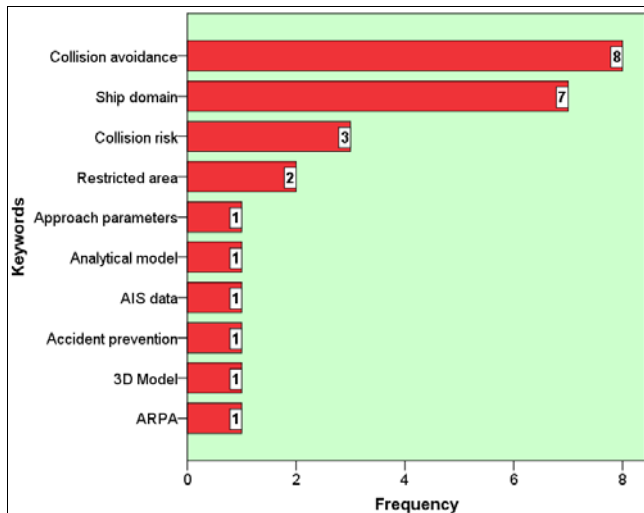


Figure 9. The keywords used in article.

5 CONCLUSION

In the literature related to 'Ship Safety Domain', Poland and China are revealed as the most contributing countries. On the other hand, there is no study prepared by major maritime countries such as Turkey, Netherland, Germany and etc. The Journal of Navigation is the most contributing journal as expected because the journal is based on navigation. The most productive periods are revealed as '2011-2016' and '2006-2010'. This shows that the topic has become a popular topic in recent years. Dalian Maritime University and Maritime University of Szczecin are the most contributing institutions. China is intensely interested in the topic and Poland is the most contributing country in EU region. 'Collision avoidance' and 'Ship domain' are the most used keywords as expected. Similarly, the words that are

most used in article titles are 'Domain', 'Ship' and 'Collision'. It is revealed that the most contributing authors are 'Ning Wang', 'Rafal Szlapczynski' and 'Zbigniew Pietrzykowski', respectively. Especially, researchers from China and Poland are mostly interested in the topic.

As a result, there is a very few study in the related field. It is thought that new researchers can focus on the topic. This is because the ship navigation can be safer if more researchers are interested in the topic.

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