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The study on the research trend about Europe ports: focus on Baltic Sea using Keyword network

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키워드네트워크 분석을 활용한 유럽항만의 연구동향 분석 :발틱해를 중심으로

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Abstract Since the 17th century, international trade has increased as a result of the development in the navigation skills. Recently, maritime transport, compared to other modes, is used more than 70% worldwide by shippers and ports, and it also has become essential in international trade. Most researchers focused only on port development, in topics like ensuring depth of water, port competition and port governance, but have left some topics undone, such as environment, ecosystem and balanced development. Therefore, this study provides insight to the academic world in port research using SNA (Social Network Analysis). The result of the SNA study shows that Baltic Sea ports researchers have focused on “Shipping”, “Marine ecosystem”and “Pollution”. The implications of this study are: first, the environment has become a main issue in the research field; second, the results suggest focusing on the main keywords from the keyword network. This study has some limitations such as excluding domestic journals and focusing in the recent 10 years.

Key Words : Baltic sea port, SNA (Social Network Analysis), Pollution, Maritime transport, Shipping

요 약 17세기 이후 항해기술의 진전과 더불어 국제무역은 증가되기 시작했다. 최근 해상운송은 화주 및 항만의 수요에 힘입어 운송모드 중 70%의 처리를 수행하고 있다. 이러한 측면에서 대부분의 연구자들은 항만개발 즉 항만수심, 항만경쟁, 항만관리 등에 집중하고 있으며, 환경, 생태계 및 조화로운 개발 등의 분야는 연구가 미진한 상황이다. 본 연구는 발틱해를 중심으로 해운, 항만 생태계, 오염 등에 집중하여 SNA 방법을 이용한 키워드네트워크를 분석하였다. 연구결과 발틱해 지역의 가장 큰 관심은 환경문제로 나타났다. 10년간의 연구기간 및 현지어로 수행된 연구결과를 포함하지 못한 한계가 있다.

주제어 : 발틱해, SNA (Social Network Analysis), 오염, 해상운송, 해운

1. Introduction

For the past decade, maritime trade in Europe has experienced a considerable growth. Maritime trade represents an essential link in multimodal transport. As it is, the globalization process has made it easier for governments and businesses to gain access to trading opportunities all over the world [1]. Our target area, the Baltic Sea, was once a referent in maritime trade, gaining advantage from the geographical location[2], the key position in the transportation corridor as a link between East and West and the growing Baltic

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economies[3]. The current situation of the Baltic Sea ports represents a challenge in terms of reinventing their maritime shipping processes, so as to improve the port services and being able to compete with other European ports, and through a better risk and environmental management [4,5].

Moreover, the threat to the marine environment that chemical transport and accidental spills represent [6] and the contamination found in sediment samples from seaport areas with a higher transport traffic [7] had brought to light the need for the strengthening of environmental policies. Since 2015, IMO (International Maritime Organization) has tightened the environmental regulation in the North Sea and the Baltic Sea area, setting a low sulfur policy, with either the use of LNG fuel or low sulfur oil, less than 70% SOx emissions [8].

By studying the research trend in the Baltic Sea seaports, the results suggest future research tasks. Korean researchers [9] have focused until now on port competition, port development and container ports. However, green ports, marine ecosystem and pollution have been relatively short of interest and research.

The research found gap in this topic shows that there are limited papers on research trend analysis in seaports in the Baltic Sea area. Moreover, only few studies using the keyword network analysis have been found. Research methodology has been limited so far to diversity analysis on topics and methodologies such as frequency analysis.

Thus, this study proposes the analysis of research related to the Baltic Sea ports for the past 10 years, In order to evaluate the change of the trend over the years, a research trend analysis of seaports in the Baltic Sea for the past 10 years will be conducted by comparing the periods 2007-2012 and 2013-2017.

The methodology applied for this study is SNA (Social Network Analysis) methodology using the “degree centrality”and “betweenness centrality”, previous filtering of 632 keywords from 133 papers. The analysis of the keyword network identified the main topics in the network, offering an overview on the flow of the research trend over the years.

The research process is as it follows. First, international and domestic background are provided, followed by a literature review where the problem that should be considered for this research is introduced. Then, comparing the results found by the previous researchers and addressing the problem to be considered, the research gap is proposed. After that, the purpose of this research is presented in the objective section, where the methodology will also be introduced. Finally, a summary or the results, implications and limitations will be mentioned and presented.

2. Literature review

2.1 Study on research trends related to logistics

Research trends using "logistics" as a keyword can be divided into research trends of logistics related academic societies and analysis of research trends concerning detailed themes.

A paper on research trends was published for "Maritime Logistics Research", a magazine of the Korea Shipping and Logistics Association from 2000 to 2012. Oh [10], No. 1 to No. 30, Yoon[11], No. 31 to No. 40, Ha (2006), No. 41 to No. 50, Koo [12], No. 51 to No. 60, and Kim[13] was analyzed from No. 61 to No. 70. They classified topics and carried out quantitative research in various parts such as frequency of research theme, frequency of researcher occupation, number of participants, frequency of research method. Park et al[14] analyzed the research trends from Vol.17 to Vol.18 of the Journal of Logistics Society, Korea's Logistics Association magazine.

Analysis of research trends on detailed themes by Yoon [15], who conducted research trends analysis for 164 academic journals concerning domestic logistics research results from 2001 to 2015. Many research on the relationship between logistics management system,

environment, partnership and logistics results had been conducted as a result of the analysis; the research method, questionnaire survey and data analysis method were mainly utilized by using regression analysis and structural equation model. Besides that, the research trend of E-Logistics was conducted by Kim et al [16] and Kim et al [17]. Cho [18] conducted research trends analysis on accounting related to logistics.

As for the research trends analysis using "trade" as a keyword, research of trends of academic societies, analysis of the research distribution and trends on specific topics were conducted. Kang et al [19] used SNA and analyzed the co-authors network of Korean trade journal magazine, revealing the network of cooperative relations and social relations for joint research. As a result of the analysis, authors with high centrality are actively conducting research as the main author and coauthor, and it turns out that the activities of co-authors have increased compared to the past. Thus, the research results were positively influenced.

The analysis of research trends on detailed topics related to trade has resulted in numerous analysis, along with advances in technologies such as E - Commerce, E - law and E - Trade. Particularly in the E-Commerce Research Vol.8, No. 1, an analysis of research trends on various forms of electronic transactions was conducted. Jang et al [20] presented implications on the research trend on E-trade and the direction of future research, and Kim et al [21] analyzed research trends on E-commerce. Lee et al [22] analyzed research trends on E-business. Jang et al [23] did a literature review of E-Law. Yoon [24] analyzed research trends in trade risk management. In addition, Koo [25] carried out research trends in the field of marine policy and Lee et al [26] analyzed the research trends in domestic cruise industry.

2.2 SNA study regarding port

The authors used Freeman [27] degree, Closeness, and Betweenness centrality to measure the importance of container ports.

Kang et al [28] analyzed the port networks of major shipping companies in the world using Social Network Analysis. As a result of the analysis, the characteristics of the port networks consisted of a network without a scale with the rule of the power function. The result of the analysis of Centrality show Asian ports such as Hong Kong, Singapore and Busan ranked high in connection, proximity and mediation center.

By using the SNA methodology, Lim et al [29] analyzed the port network based on the moving trade volume by shipping nationality of Korea, China, Japan and Taiwan. Hong Kong Port was the best in terms of connectivity centrality.

Kim [30] conducted a study on China's port concentration and trade through an HHI and SNA analysis. The analysis shows that Busan Port is the most concentrated, but it confirms that the proportion of the ports in the West Coast is gradually increasing.

Kim [31] has analyzed the RoRo Perrier route between Korea, China and Japan using SNA. The authors raised the feasibility of introducing RoRo Perry in the context of the Korea - China - Japan FTA signing.

Park et al [32] studied the change of container liner route around Incheon port using Social Network Analysis. By analyzing quarterly time series data from 2008 to 2015, Hong Kong Port and Busan Port have consistently high centered. However, the eastern ports of Singapore and China show low centrality, and the high influence of the trade volume observed in those areas differs with the not so positive network analysis results.

Lim [33] applied SNA's eigenvector centrality and PageRank centrality to measure the influence of harbors. The paper is characterized by the use of DEA lambda values for social network analysis. After applying the page rank centrality, Lianyungang, Shenyang, Shanghai and Hong Kong were ranked in high positions.

Son [34] assessed the impact of efficient container terminals. The author selected three terminals in

Gwangyang Port and ten terminals in Busan Port. The analysis shows that HJNC terminal in Busan Port is the most influential, followed by PNC and Wuam Pier. The authors presented the limitations of constructing the BCC model only in the social network.

Joo [35] studied network aspects from the factors of innovation and human interaction in Korea's national innovation system. As a result, Korea's network of national innovation system in information and communication sector appeared to be a narrow world network type.

Kim et al. [36] used the SNA to study the relationship between items purchased by consumers. As a result of analysis, young casual was derived as a product with high centrality. The authors suggested that this could be an important piece of information for marketing strategy development.

Kim [37] studied the diffusion of information and changes in distribution channels in the internet environment to predict social change. Using SNA method, the author argued that the influence of the portal site has increased as a media for individuals to obtain information.

Lee et al [38] studied cultural differences in on-line using SNA based on Hofstede's cultural dimension. The authors analyzed cell phone related word of mouth data collected from online communities in Korea, US and UK. As a result of the analysis, result were in contradiction with offline claims.

2.3 Research trends using SNA

Ko et al [39] conducted a study trend analysis using SNA to analyze the macro flow of technical management-related studies. The author has discovered that the newly created keywords are linked based on existing highly-connected keywords.

Yang [40] studied the research trends through the articles published in 'International Commerce and Information' using SNA. The authors suggested that research is needed to statistically validate these indicators with social network analysis indicators.

Song et al [41] studied research trends in the Chinese OBOR(One Belt One Road) project using SNA analysis. The authors suggested that OBOR study is underway for a short time, but lacks research to study the details of the project.

2.4 Research gap

Previous research in the international and domestic field showed several studies using SNA to analyze route networks, based on traffic and freight volume, or the commonly used keyword analysis for the research on small field industries such as the world cruise industry. Most of the detailed research trend analysis in the logistics field have already been analyzed previously in journals.

The research found gap in this topic shows that there are limited papers on research trend analysis in seaports in the Baltic Sea area. Moreover, few studies using the keyword network analysis have been found.

Research methodology has been limited so far to diversity analysis on topics and methodologies such as frequency analysis.

Regarding this aspect, this study analyzes Baltic Sea ports related papers for the past 10 years. In order to evaluate the change through the years, a research trend of ports in the Baltic Sea will be conducted by comparing the periods 2007-2012 and 2013-2017 by equally dividing the number of papers.3. SNA(Social Network Analysis)

Social network analysis is a study that deduces the social relation structure in the network by measuring the relationships among actors in the network [42]

Social Network Analysis results do not offer independent characteristics of each node in the network; instead, the information obtained from the analysis of the network characteristics represents the nodes and the relation between them. The information obtained through Social Network Analysis includes "degree centrality"and "betweenness centrality", among others [43]

Unlike traditional statistical method, SNA is able to

analyze the relationship between the keywords of theses and visualize the relationship of each keyword. Therefore, there is an advantage that the research trend can be known more objectively.

The research framework of this paper follows the structure shown in Fig. 1.

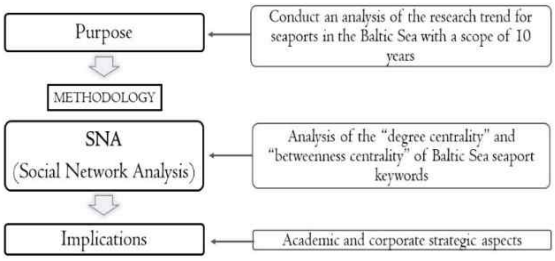

Fig. 1. Research Flow chart

The degree of centrality is the concept of centering connected nodes between points. This is measured by the number of nodes connected to each point, and the more nodes connected to each node, the higher the connection centrality is analyzed. The connection centrality of node i means the connectivity of nodes in the network. Assuming that node i and node j are connected, $a_{ij}=1$, otherwise $a_{ij}=0$ can be defined as follows.

$$C_D(i)=\sum_{j=1}^{n}a_{ij} \quad (1)$$

Betweenness centrality is a measure of the role of a mediator or arbiter in a network structure. That is, it measures whether a point plays the role of a broker in establishing a network with other points.

$C_B(i)$ is the ratio of all the shortest paths through node i. In the equation, g_{jk} denotes the number of the shortest distance link between j and k, and g_{jk} denotes the number of times passing through point i between two points j and $k(j\neq k)$.

$$C_b(i)=\sum_{j<k}^{n}g_{jk}(i)/g_{jk} \quad (2)$$

In this paper, This research use two centralities as degree and betweenness. The reason why this study selected betweeness is core subjects cannot be defined only degree because of the characteristic of centrality in SNA. Also the clustering process is organized by betweeness centrality.

4. Case study

4.1 Data Collection

This study uses Science Direct, Emerald, Scopus and Springer, major research DB (Data Base). The target papers in this research are the ones published from 2007 to 2017 with the defined keywords “Baltic sea”and “Port.” In other words, the analysis object range are articles where these keywords appear in either title, abstract and keyword, except for presentation papers. and the collected keyword information is confirmed and necessary modifications are made to suit the analysis. This is a process to increase the accuracy of analysis results through keywords of the same meaning among the articles published in academic journals. It also includes the process of deleting data that needs to be excluded from the analysis and creating data for analysis.

The following Table 1 presents the number of papers for each journal analyzed in the research.

Table 1. The number of articles used in the study by Journal

Journal	Frequency	Journal	Frequency
Baltica	10	Journal of Transport Geography	2
WMU Journal of Maritime Affairs	6	Kuste	2
Environmental Science and Pollution Research	4	Marine Pollution Bulletin	2
Transport	4	Maritime Economics & Logistics	2
Environmental Governance of the Baltic Sea	3	Maritime Logistics: Contemporary Issues	2
Journal of Coastal Research	3	Polish Journal of Environmental Studies	2
Oceanologia	3	Polish Maritime Research	2

Oil Pollution in the Baltic Sea	3	Science of the Total Environment	2
Transport and Telecommunication	3	Territoire en Mouvement	2
Aquatic Invasions	2	Transportation Research Part D: Transport and Environment	2
Environmental Monitoring and Assessment	2	Transportation Research Procedia	2
Journal of Shipping and Trade	2	other 67 Jounal	67

A total of 632 keywords have been defined through a keyword filtering process. The number of papers and keywords used in the analysis can be observed in the following Fig. 2.

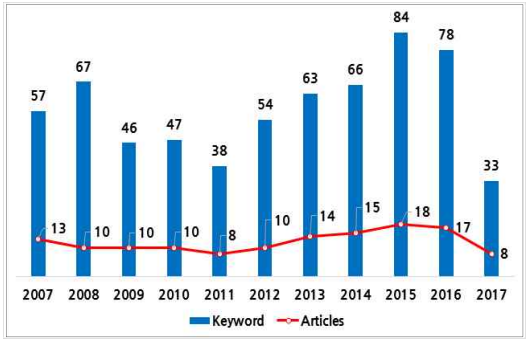

Fig. 2. The number of articles and keywords by year

4.2 The results of SNA for the whole period

For Degree centrality results, the keywords in order are Sediment, Salt, Shipping, Simulation and Intermodal. “Sediment”having the most frequency of connection to other nodes demonstrates that many researchers have considered marine ecosystem and geology while researching seaports in the Baltic Sea area. “Eutrophication”, “Introduced Species”and “Plankton”in lower positions also have a similar meaning. “Salt”and “Brackish Water” keywords show the other trend in the Baltic Sea. As the Baltic Sea is located near the North Pole, the salt level in the Baltic waters is around 10%. With global warming and poles melting, topics such as levels of salt in marine waters are becoming important.

Frequent keywords in the Shipping field are “Intermodal”and “Short Sea Shipping”. Recently, “Intermodal”is a major trend of shipping in the world. Because of the Baltic Sea geographical location advantage feeder networks can be easily developed. “Short Sea Shipping”with a high position in the rank is also an attractive factor to researchers.

“Oil Pollution”and “Oil Spill”are also considered important issues in the Baltic Sea. The IMO (International Maritime Organization) has tightened the environmental regulation in the North Sea and the Baltic Sea since 2015. All the ships passing by the North Sea and the Baltic Sea should use either LNG fuel or Low Sulfur Oil with emissions of less than 70% SOx.

The following Table 2 and Table 3 show the results of Degree and Betweenness centralities for the whole period (2007-2017).

Table 2. The results of Degree centrality (2007-2017)

NO.	keyword	value	NO.	keyword	value
1	Sediment	42	21	Low Temperature	16
2	Salt	28	22	Map	16
3	Shipping	27	23	North Atlantic	16
4	Simulation	24	24	Oil Spill	16
5	Intermodal	21	25	Survey	16
6	Eutrophication	20	26	Survival	16
7	IMO	20	27	Port Authority	15
8	Logistics	20	28	Container Port	14
9	Risk	20	29	Ship	13
10	Short Sea Shipping	20	30	Ballast Water	12
11	Oil Pollution	18	31	Heavy Metal	12
12	Pollution	18	32	Plankton	12
13	Anthropogenic Factor	16	33	Contaminant	11
14	Atlantic Ocean	16	34	Environmental Impact Assessment	11
15	Ballast Tank	16	35	Finland	11
16	Brackish Water	16	36	Port Governance	11
17	Community	16	37	Region	11
18	Introduced Species	16	38	Risk Assessment	11
19	Invasion	16	39	Sweden	11
20	Invertebrata	16	40	Climate Change	10

“Sediment”, “Shipping” and “Salt” networks are the following figures.

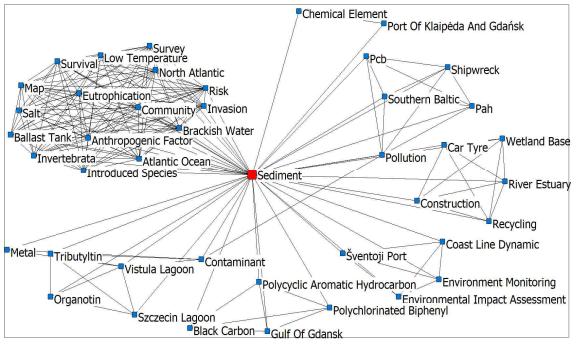

Fig. 3. “Sediment”keyword network

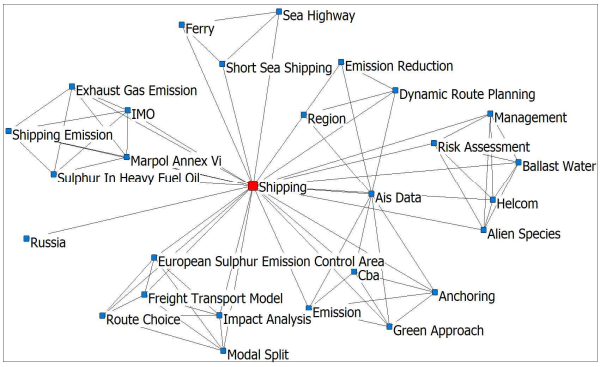

Fig. 4. “Shipping”keyword network

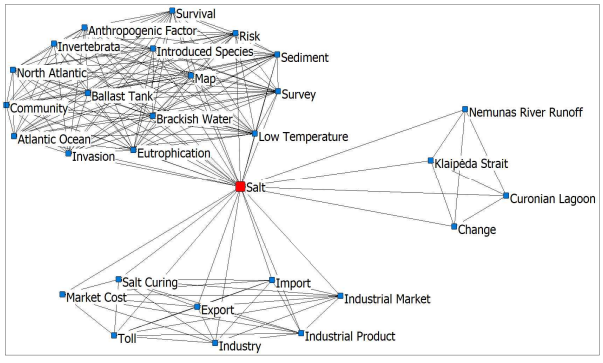

Fig. 5. “Salt”keyword network

For Betweenness centrality, the most common keywords in the research trend in order are “Shipping”, “Sediment”, “Short Sea Shipping”, ‘Oil Spill’and “Pollution”.

The results are quite similar to Degree centrality, except for some keywords that hold a higher rank such as “Ferry”and “Transport.”

Table 3. The results of Betweenness centrality (2007-2017)

NO.	keyword	value	NO.	keyword	value
1	Shipping	11698	21	Port Authority	3071
2	Sediment	11037	22	Oil Transport	2858
3	Short Sea Shipping	8103	23	Environmental Impact Assessment	2471
4	Oil Spill	7439	24	Plankton	2236
5	Pollution	7267	25	Emission	2231
6	Salt	6896	26	Logistics	2172
7	Container Port	6181	27	Trend	2144
8	South Eastern Baltic	5986	28	Tributyltin	2094
9	Oil Pollution	5566	29	Gulf Of Riga	2093
10	Simulation	5198	30	Heavy Metal	2093
11	Ballast Water	4939	31	Russia	2053
12	Risk	4889	32	Ship	1997
13	IMO	4693	33	Climate Change	1808
14	Region	3553	34	Risk Assessment	1808
15	Intermodal	3546	35	Ferry	1692
16	Port Governance	3485	36	Pollution Spread	1455
17	Eutrophication	3468	37	Transport	1366
18	Curonian Lagoon	3253	38	Sea Environment	1353
19	Helcom	3153	39	Gulf Of Finland	1330
20	Contaminant	3124	40	Recycling	1281

4.3 The result of SNA each period

Focusing on the 2nd period, almost all the keywords are changed compared to the first one. In 2007-2012, Marine Ecosystem related nodes like “Sediment”, “Salt”and “Eutrophication”take higher ranks than other nodes. During the period of 2013 to 2017 almost all keywords, including “oil”had been replaced by pollution keywords, except “Sediment”. The following Table 4 is the result of Degree and Betweenness centralities by dividing an equal number of papers (2007-2012, 2013-2017).

The results of Betweenness centrality show similar pattern to the results for Degree centrality. Ecosystem related nodes like “Sediment”, “Helcom”(The Baltic Marine Environment Protection Commission) and “Eutrophication”, are changed to “Pollution”related nodes (Air Pollution, Oil Spill and Emission) and “Shipping”related nodes (Cruise Ship, Shipping and Short Sea Shipping) from the 1st period to the 2nd period.

Table 4. The results of Degree centrality by period

2007-2012			2013-2017		
NO.	keyword	value	NO.	keyword	value
1	Sediment	34	1	Simulation	24
2	Salt	28	2	Shipping	16
3	Eutrophication	20	3	Ship	13
4	Risk	20	4	Finland	11
5	North Atlantic	17	5	Sweden	11
6	Anthropogenic Factor	16	6	Oil Pollution	10
7	Atlantic Ocean	16	7	Oil Spill	10
8	Ballast Tank	16	8	Sediment	10
9	Brackish Water	16	9	Design	9
10	Community	16	10	Emission	9
11	IMO	16	11	Exhaust System	9
12	Introduced Species	16	12	Fluid	9
13	Invasion	16	13	Heat Recovery	9
14	Invertebrata	16	14	Intermodal	9
15	Low Temperature	16	15	Organic Rankine Cycle	9
16	Map	16	16	Poland	9
17	Survey	16	17	Stress	9
18	Survival	16	18	Temperature	9
19	Short Sea Shipping	14	19	Turbine	9
20	Intermodal	13	20	Ais Data	8

Table 5. The results of Betweenness centrality by period

2007-2012			2013-2017		
NO.	keyword	value	NO.	keyword	value
1	Shipping	3331	1	Air Pollution	2263
2	Risk	3268	2	Cruise Ship	2128
3	Sediment	3233	3	Sea Environment	1975
4	Oil Spill	3101	4	Simulation	1595
5	Helcom	3062	5	Oil Spill	1545
6	Salt	2696	6	Port Governance	1459
7	Ballast Water	2631	7	Oil Transport	1439
8	Eutrophication	2557	8	Shipping	1374
9	Russia	1730	9	South Eastern Baltic	1336
10	IMO	1691	10	Region	1153
11	Trend	1600	11	Port State Control	940
12	Flow	1298	12	Sea Accident	679
13	Plankton	1057	13	Short Sea Shipping	615
14	Pollution Spread	1014	14	Ship	571
15	Curonian Lagoon	1005	15	Emission	555
16	Gulf Of Finland	951	16	Tributyltin	482
17	Amphipod	744	17	Sediment	402
18	Pollution	725	18	Oil Pollution	399
19	Short Sea Shipping	715	19	Pollution	392
20	Intermodal	598	20	Contaminant	366

5. CONCLUSION

Utilizing Social Network Analysis, the results of research trend analysis obtained are as it follows. As a result of Degree and Betweenness centralities for the whole period (2007-2017), the most central subjects are “Sediment”and “Shipping.” In case of Degree centrality, keywords associated with Marine ecosystem, Shipping, and Oil pollution rank in high positions. In contrast, “Ferry”and “Transport”appear in high positions in Betweenness centrality. For results of Degree and Betweenness centralities compared in two periods (2007-2012, 2013-2017), dividing into the same number of papers, both of the periods tend to change from Marine ecosystem to Pollution and Shipping keywords.

Based on the results, networks consist of related words, divided into three main subjects, “Shipping”, “Pollution”and “Marine ecosystem”. Shipping network is also made up of 4 subgroups, “Short Sea Shipping”, “Bulk shipping”, “Transport”and “Shipping. Pollution”. “Air Pollution”and “Oil Pollution”are connected to each other in the Pollution network. Lastly, Marine ecosystem consists of “Sediment”and “Marine ecosystem change”.

this study can be confirmed that interest in marine environment which has not yet been activated in domestic research has become a social and research issue in the Baltic Sea region early. In particular, relevant research trends in the Baltic Sea, which enforces the globally highlighted ECA regulations, could suggest implications for many stakeholders in the future. As a result of this study, study regarding the Baltic Sea region was considered to have centrality in keywords such as "sediment", "shipping", and "risk"

The implications of this study are the following. Firstly, the keyword network analysis of the Baltic Sea area provides numerous related results such as “pollution”, “green port”or “oil spill”. it’s time to pay attention to environment problem about port. In research trend baltic sea port by each period, all of the centralities show that the tendency of study has been

changing to “Pollution”. Therefore, the academic should consider variety environmental subjects like as sea environment, green port and oil spill.

Secondly, the research field in the future, this study included, should cover a longer period and be more detailed about the keywords and research subjects. Among the keywords analyzed for the clustering process, “Short Sea Shipping”and “Emission”have not been fully researched in the domestic field. By covering a wider range of keywords, researchers can strive for a balanced research direction.

However, there are limitations for this research. First, domestic articles have not been considered because of a language barrier, thus it was difficult to analyze the results as conclusive. Future researchers should explore this topic using domestic research, in order to obtain more accurate results. To conclude, this research is based only in the last 10 years of research trend analysis. Therefore, researchers ought to expand this research scope in future research.

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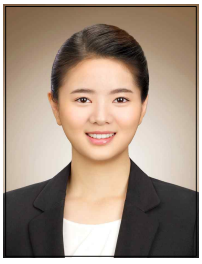

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