An Analysis of the Trends in the Arena of Cooperation by the International Research Cooperation Related Experts

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ABSTRACT

The International Research Cooperation Information Center has carried out a project to collect the DBs related to the international research cooperation information, and build an online service system. This study seeks to examine and understand the trends of international research cooperation by analyzing the data corresponding to the other international cooperation DBs such as symposium and seminar, which may be said to be the arena of cooperation by the international research cooperation related experts, among the international research cooperation information DBs collected by the International Research Cooperation Information Center. The other international cooperation DBs are divided into the international cooperation consortium, international cooperation symposium, international research cooperation seminar, international training program, international research cooperation workshop, and the international research cooperation equipment / facility. It seems that, based on the research results, it is necessary to hold international cooperation programs, seminars, and workshops, among others, with a focus on the themes to recover the trends of international cooperation as in the past, and recover from the pandemic situation. The results of this study may be utilized as the basic data for the researchers related to the international research cooperation, and furthermore, by analyzing various international research cooperation information DBs in a multi-faceted manner, the studies analyzing the research trends of international research cooperation by field, subject, and type may be conducted, and the facilitation of the international research cooperation in Korea is expected moving forward.

1. Introduction

In the era of globalization, each nation around the globe is elevating its expertise and diversity based on the international cooperation in each field such as politics, economy, and society. In particular, international research cooperation is a precondition to surviving in the unlimited global competition for conducting high level research beyond the restrictions of one's own resources and manpower.

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In Korea, while emphasizing the importance of scientific research for the production of knowledge for the technological development, policy efforts to strengthen the connection and the mutual cooperation among various innovative principals including universities, companies, governments, and research institutes are continuously carried out. Especially, emphasis is locationd on the need for an environment in which the scientific knowledge and information produced by the public sector research institutions, such as universities, research institutes, and government agencies, may be utilized for the technological development and the innovative production of companies (Donghoon Oh and Hyerin Ahn, 2009).

More than anything, in Korea, each ministry collects and manages the systematic collection, accumulation, management, and the distribution of task information and research performance information related to the national research and development projects in terms of task management. However, it is not only difficult to access and utilize it with ease from the perspective of consumers, but also, it was pointed out that the comprehensive preservation and management at the level of all ministries has not been properly carried out. Accordingly, through the National Science & Technology Information Service (NTIS) of the Ministry of Science, ICT and Future Planning, and the National Research Information Center (NRIC) of the National Research Foundation of Korea, specialized research centers, projects, tasks, manpower, research facilities and equipments, and performance achievements, among other information on the national research and development projects began to be provided in a single location (website of the NTIS, https://www.ntis.go.kr).

However, the information of the institutions conducting the international research cooperation has not yet been collected in a single location, and instead, it is carried out in the unit of institution, and hence, there is a limit by which the consumers including the researchers who want the international research cooperation cannot search for the research cooperation information in a single location. It may be considered that there is hardly any information management on the research cooperation information and the information on research partners such as international research cooperation institutions of each government ministry, colleges and universities, and research institutes which actively conduct the international research cooperation. Therefore, the representative national institutions ought to systematically collect and manage them, induce the facilitation of their use, and devise the policies for their continued preservation.

Given such need, the International Research Cooperation Information Center is carrying out a project to collect the DBs related to the international research cooperation related information, and build an online service system. Among the international research cooperation information DBs collected by the International Research Cooperation Information Center, this study seeks to examine and understand the trends of international research cooperation by analyzing the data corresponding to the DBs related to symposiums and seminars, among others, which may be said to be the arena of cooperation by experts related to the international research cooperation.

The results of this study may be utilized as the basic data for the researchers related to the international research cooperation, and furthermore, by analyzing the various international research cooperation information DBs in a multi-faceted manner, the studies analyzing the international research cooperation research trends by field, topic, and type may be conducted, and the facilitation of the international research cooperation in Korea is expected moving forward.

2. Methodology

To achieve the purpose of this study, this study was conducted with the following research contents and methods. First, in the case of the international cooperation consortium, as specified by the project proposal, the DB was developed based on the 10 institutions of the Korea Brain Research Institute, Korea National Institute of Health of the Korea Center for Disease Control and Prevention, APEC Research Center, Eone Diagnomics Genome Center, Hanbat National University, Korea Shipbuilding & Marine Equipment Global Support Center, Korea Foundation, Korea International Trade Association, Chungnam National University, and the Worldwide Consortium of Korean Studies Center. The consortium DB was developed based on the institution specified in the business plan, and if the URL of the metafield is visited, the basic information about the consortium hosted by the institution is displayed as a default, based on which the required metafield may be prepared. In the case of the items specified as "Yes" or "Affirmative" in the metafield of "Classification of whether a file is attached," inadequate information was searched in the relevant attachment files for development.

Second, in the case of the international cooperation symposium, a DB was developed by searching with the keyword of "international symposium" on the website of the National Library of Korea. Aside from which, DBs were developed via the symposiums hosted by the institutions provided in the list of DBs on some international cooperation institutions through the website of the relevant institution and Google search.

Third, in the case of the international research cooperation seminar, an international cooperation seminar was developed based on the institutions provided in the list of international cooperation institution DBs and the institutions specified in the business plan. Furthermore, if the URL specified in the metafield of "URL" is visited, the information on the required metafield can be searched. In the case of the items specified as "Yes" or "Affirmative" in the metafield of "Classification of whether a file is attached," inadequate information was searched in the relevant attachment files for development.

Fourth, in the case of the international training program, a DB was developed by searching for such keywords as "international training" and "international training program" at Google. When the URL of the relevant international training program is visited, the basic information can be found, and in the case of the items specified as "Yes" or "Affirmative" in the metafield of "Classification of whether a file is attached," inadequate information was searched in the relevant attachment files for development.

Fifth, in the case of the international research cooperation workshop, an international cooperation workshop DB was developed based on the institutions provided in the list of international cooperation institution DBs, and the institutions specified in the business plan.

First, how to build an international cooperation workshop DB may be explained by taking the "Korea Centers for Disease Control and Prevention" as an example. When the URL of the metafield is visited, the basic information on the workshop hosted by the institution is displayed as a default. Based on this information, the required metafield may be prepared. In the case of the items specified as "Yes" or "Affirmative" in the metafield of "Classification of whether a file is attached," inadequate

information was searched in the relevant attachment files for development.

Lastly, concerning the international research cooperation equipment / facility, in the 2012 Report on the Status Survey of Large Scale National Research Facilities by the Ministry of Science, ICT and Future Planning, a total of 19 cases were discovered for the facilities at which international joint researches were conducted for 3 years from 2009 to 2011 (refer to **Table 1**). Based on that list, an international research cooperation equipment / facility DB was developed.

Table 1. Procedures and Methods for the Development of Other DB on the International Research Cooperation

Component	Contents
International cooperation consortium DB	As specified in the project proposal, a DB was developed based on the 10 institutions of the Korea Brain Research Institute, Korea National Institute of Health of the Korea Center for Disease Control and Prevention, APEC Research Center, Eone Diagnomics Genome Center, Hanbat National University, Korea Shipbuilding & Marine Equipment Global Support Center, Korea Foundation, Korea International Trade Association, Chungnam National University, and the Worldwide Consortium of Korean Studies Center.
International cooperation symposium DB	DB was developed by searching for the keyword of "international symposium" at the website of the National Library of Korea. DB was developed via searching "symposium" hosted by the institutions on the list of some of the international cooperation institution DBs at the website of the relevant institutions and via Google search.
International research cooperation seminar DB	International cooperation seminar was developed based on the institutions specified in the list of international cooperation institution DBs and the institutions specified in the business plan.
International training program DB	DB was developed by searching the keywords of "international training" and "international training program" on Google.
International research cooperation workshop DB	The international cooperation workshop DB was developed based on the institutions specified in the list of international cooperation institution DBs and the institutions specified in the business plan.
International research cooperation equipment / facility DB	The 2012 Report on the Status Survey of Large Scale National Research Facilities by the Ministry of Science, ICT and Future Planning provides a total of 19 discoveries made for the facilities at which international joint researches were conducted for 3 years from 2009 until 2011. The international research cooperation equipment / facility DB was developed based on that list.

3. Theoretical Background

3.1 International Cooperation Consortium

As for the type of the international cooperation consortium (IR06-A), enter the consortium related information related to the international cooperation. The required fields are classified into the IR

type code, IR detailed type code, proprietary number, classification of country, name of material / name of program, institution of issuance, year of publication, introduction, URL, host institution, and the presence or absence of the attachment files, while the optional fields were set to the name of meeting, date and time, and location, respectively. The explanation for each metafield of the international cooperation consortium is as follows.

Table 2. Metafield of the International Cooperation Consortium

Name of Metafield	Required / Optional	Description of Field
IR type code	Required	Type code of the relevant consortium All other IR type codes related to the international research cooperation are unified as IR06
IR detailed type code	Required	Detailed type code of the relevant institution international cooperation Consortium: IR06-A
Proprietary number	Required	Proprietary number of the relevant consortium Example: Start with IR06_A_00001 in the order
Classification of country	Required	Field of country classification for the relevant consortium (using classification of country code Example: Korea (KR), Japan (JP), etc.
Name of material / Name of program	Required	Name of the consortium
Institution of issuance	Required	Name of the site from which the consortium's information was imported
Year of issuance	Required	Host year of the consortium
Introduction	Required	Introduction of the consortium
URL	Required	URL to verify the information of the consortium
Name of meeting	Optional	Enter the name of the consortium
Date and time	Optional	Enter the relevant consortium date and time Example: 11/03/2015-11/04/2016
Location	Optional	Enter the consortium's location
Host institution	Required	Enter name of the host institution hosting the consortium Specify if it is separated from the host institution
Classification of the presence and absence of attachment files	Required	Enter the presence or absence of attachment files related to the consortium

3.2 International Cooperation Symposium

As for the type of international cooperation symposium (IR06-B), enter the symposium related information related to the international cooperation. The required fields were set to the IR type code, IR detailed type code, proprietary number, classification of country, name of material / name of program, institution of issuance, year of publication, introduction, URL, date and time, and whether there are attached files. The explanation for each metafield of the international cooperation symposium is as follows.

Table 3. Metafield of the International Cooperation Symposium

Name of Metafield	Required / Optional	Description of Field
IR type code	Required	Type code of the symposium All other IR type codes related to the international research cooperation are unified as IR06
IR detailed type code	Required	Detailed type code of the symposium international cooperation symposium: IR06-B
Proprietary number	Required	Proprietary number of the symposium Example: Start with IR06_B_00001 in the order
Classification of country	Required	Field of classification of the symposium (using classification of country code Example: Korea (KR), Japan (JP), etc.
Name of material / Name of program	Required	Name of the symposium
Institution of issuance	Required	Name of the site from which the symposium's information was imported
Year of issuance	Required	Host year of the symposium
Introduction	Required	Introduction of the symposium
URL	Required	URL to verify the information of the symposium
Name of meeting	Optional	Enter the symposium's name
Date and time	Required	Enter the symposium's date and time Example: 11/03/2015-11/04/2016
Location	Optional	Enter the symposium's location
Host institution	Optional	Enter the name of host institution hosting the symposium
Classification of the presence and absence of attachment files	Required	Enter the presence or absence of attachment files related to the symposium

3.3 International Research Cooperation Seminar

As for the type of international research cooperation seminar (IR06-C), enter the information related to the international cooperation. The required fields were set to the IR type code, IR detailed type code, proprietary number, classification of country, name of material / name of program, institution of issuance, year of publication, introduction, URL, date and time, location, host institution, and the presence or absence of the attachment files. The explanation of each metafield of the international research cooperation seminar is as follows.

Table 4. Metafield of the International Research Cooperation Seminar

Name of Metafield	Required / Optional	Description of Field
IR type code	Required	Type code of the seminar All other IR type codes related to the international research cooperation are unified as IR06
IR detailed type code	Required	Detailed type code of the seminar

		International cooperation consortium: IR06-C
Proprietary number	Required	Proprietary number of the seminar Example: Start with IR06-C_00001 in the order
Classification of country	Required	Field of classification of country of the seminar (using the classification of country code Example: Korea (KR), Japan (JP), etc.
Name of material / Name of program	Required	Name of the seminar
Institution of issuance	Required	Name of the site from which the seminar's information was imported
Year of issuance	Required	Host year of the seminar
Introduction	Required	Introduction of the seminar
URL	Required	URL to verify the information of the relevant international research cooperation seminar
Name of meeting	Optional	Enter the seminar's name
Date and time	Required	Enter the seminar's date and time Example: 11/03/2015-11/04/2016
Location	Required	Enter the seminar's location
Host institution	Required	Host the name of host institution hosting the seminar Specify if it is separated from the host institution
Classification of the presence and absence of attachment files	Required	Enter the presence or absence of attachment files related to the seminar

3.4 International Training Program

As for the type of international training program (IR06-D), enter the information related to the training programs related to the international cooperation. The required fields were set to the IR type code, IR detailed type code, proprietary number, classification of country, name of material / name of program, institution of issuance, year of publication, introduction, URL, date and time, location, host institution, and the presence or absence of the attachment files. The explanation of each metafield of the international training program is as follows.

Table 5. Metafield of the International Training Program

Name of Metafield	Required / Optional	Description of Field
IR type code	Required	Type code of the relevant international training program All other IR type codes related to the international research cooperation are unified as IR06
IR detailed type code	Required	Detailed type code of the relevant international training program International cooperation consortium: IR06-D
Proprietary number	Required	Proprietary number of the relevant international training program Example: Start with IR06_D_00001 in the order
Classification of country	Required	Field of country classification of the relevant international training program (use the classification of country code

		Example: Korea (KR), Japan (JP), etc.
Name of material / Name of program	Required	Name of the international training program
Institution of issuance	Required	Name of the site from which the information of the international training program was imported
Year of issuance	Required	Host year of the international training program
Introduction	Required	Introduction of the international training program
URL	Required	URL to verify the information of the international training program
Name of meeting	Optional	Enter the name of the relevant international training program
Date and time	Required	Enter the relevant International training program's date and time Example: 11/03/2015-11/04/2016
Location	Required	Enter the corresponding international training program's location
Host institution	Required	Enter the name of the host institution hosting the international training program
Classification of the presence and absence of attachment files	Required	Enter the presence or absence of attachment files related to the international training program

3.5 International Research Cooperation Workshop

As for the type of international research cooperation workshop (IR06-E), enter the information related to the international cooperation workshop. The required fields were set to the IR type code, IR detailed type code, proprietary number, classification of country, name of material / name of program, institution of issuance, year of publication, introduction, URL, date and time, location, host institution, and the presence or absence of the attachment files. The explanation for each metafield of the international research cooperation workshop is as follows.

Table 6. Metafield of the International Research Cooperation Workshop

Name of Metafield	Required / Optional	Description of Field
IR type code	Required	Type code of the workshop All other IR type codes related to the international research cooperation are unified as IR06
IR detailed type code	Required	Detailed type code of the corresponding workshop international cooperation workshop: IR06-E
Proprietary number	Required	Proprietary number of the workshop Example: Start with IR06-E-00001 in the order
Classification of country	Required	Field of country classification of the workshop (using the classification of country code Example: Korea (KR), Japan (JP), etc.
Name of material / Name of program	Required	Name of the workshop
Institution of issuance	Required	Name of the site from which the workshop information was imported
Year of issuance	Required	Host year of the workshop

Introduction	Required	Introduction of the workshop
URL	Required	URL to verify the information of the workshop
Date and time	Required	Enter the corresponding workshop's date and time Example: 11/03/2015-11/04/2016
Location	Required	Enter the corresponding workshop's location
Host institution	Required	Enter the name of the workshop's host institution
Classification of the presence and absence of attachment files	Required	Enter the presence or absence of attachment files related to the workshop

3.6 International Research Cooperation Equipment / Facility

As for the type of equipment / facility (IR06-F), enter the equipment / facility related information of the research institute related to the international cooperation. The required fields were set to the IR type code, IR detailed type code, proprietary number, classification of country, institution name, website, location, introduction of institution, target equipments (units), contents of international cooperation, and the address of the international cooperation list. It was set to the presence or absence of the attachment files. The explanation of each metafield of the international cooperation equipment / facility is as follows.

Table 7. Metafield of the International Cooperation Equipment / Facility

Name of Metafield	Required / Optional	Description of Field
IR type code	Required	Type code of the DB All other IR type codes related to the international research cooperation are unified as IR06
IR detailed type code	Required	Detailed type code of the DB international cooperation equipment / facility: IR06-F
Proprietary number	Required	Proprietary number of the DB Example: Start with IR06-F_00001 in the order
Classification of country	Required	Field of country classification of the DB (using the classification of country code Example: Korea (KR), Japan (JP), etc.
Name of institution	Required	Name of the research institute which owns the relevant equipment / facility
Website	Required	Web address of the research institute which owns the relevant equipment / facility
Location	Required	Location of the research institute which retains the relevant equipment / facility
Introduction of the institution	Required	Introduction of the research institute which retains the equipment / facility
Target equipments (units	Required	Number of equipments retains by the research institute which owns the relevant equipment / facility
Contents of international cooperation	Required	Contents of the international cooperation of the research institute which owns the relevant equipment / facility

Y. Noh, J. Y. Ro, & W. Kwak

Address of the international cooperation list	Required	URL of the list of international cooperation of the research institute which owns the relevant equipment / facility

4. Analytical Results

4.1 Equipment and Facility DB

As for the type of equipment / facility (IR06-F), the information related to the equipment / facility of the research institute related to the international cooperation was entered, and a total of 19 cases were collected. A brief examination of the statistically significant contents is as illustrated in **Table 8**. The 19 institutions of the collected installation and facility DB all correspond to such different institutions as the Korea Institute for Advanced Study and the Korea Institute of Science and Technology, and the majority of those owning the equipments and facilities related to the international cooperation research turned out to be located in Daejeon (10 cases).

Table 8. List of the Installation and Facility DBs

Serial No.	Name of institution	No. of Units	Location
1	Korea Institute for Advanced Study	1	Seoul
2	Korea Institute of Science and Technology	1	Seoul
3	Korea Institute of Radiological & Medical Sciences	1	Seoul
4	Korea Internet & Security Agency	1	Jeollanam-do
5	Institute for Advanced Engineering	1	Gyeonggi-do
6	Korea Institute of Construction Technology	1	Gyeonggi-do
7	Korea Institute of Industrial Technology	1	Chungcheongnam-do
8	Korea Atomic Energy Research Institute	1	Daejeon
9	Korea Advanced Institute of Science and Technology	1	Daejeon
10	Korea Institute of Machinery and Materials	1	Daejeon
11	Korea Basic Science Institute	1	Daejeon
12	National AI Research Institute	1	Daejeon
13	Korea Astronomy and Space Science Institute	1	Daejeon
14	Korea Research Institute of Standards and Science	1	Daejeon
15	Korea Aerospace Research Institute	1	Daejeon
16	Korea Research Institute of Chemical Technology	1	Daejeon
17	Gwangju Institute of Science and Technology	1	Gwangju
18	Korea Electrotechnology Research Institute	1	Gyeongsangnam-do
19	National Information Society Agency	1	Daejeon
Total		19	-

As for the target equipments, the Korea Atomic Energy Research Institute turned out to have the most with 330 units, and the average target equipments of 19 institutions turned out to be 25.32 units.

Table 9. Target Equipments of the Installation and Facility DBs

Serial No.	Name of institution	Target Equipments (Units)
1	Korea Institute for Advanced Study	1
2	Korea Institute of Science and Technology	2
3	Korea Institute of Radiological & Medical Sciences	2
4	Korea Internet & Security Agency	7
5	Institute for Advanced Engineering	18
6	Korea Institute of Construction Technology	1
7	Korea Institute of Industrial Technology	23
8	Korea Atomic Energy Research Institute	330
9	Korea Advanced Institute of Science and Technology	13
10	Korea Institute of Machinery and Materials	15
11	Korea Basic Science Institute	1
12	National AI Research Institute	8
13	Korea Astronomy and Space Science Institute	1
14	Korea Research Institute of Standards and Science	5
15	Korea Aerospace Research Institute	18
16	Korea Research Institute of Chemical Technology	9
17	Gwangju Institute of Science and Technology	19
18	Korea Electrotechnology Research Institute	2
19	National Information Society Agency	6

Major keywords were verified by deriving the words of high frequency of emergence based on the "introduction of facility" concerning the installation and facilities, and **Table 10** presented the top 60 words based on the frequency of emergency in the introduction of facility. The keywords of the highest frequency of emergence are "Institution (11 times)," "Establishment (10 times)," "Research (10 times)," "Development (8 times)," "Performance (8 times)," and "Country (7 times)," respectively.

However, such results which simply demonstrate the frequency are meaningful in that they demonstrate the overall keywords for the public who have almost no knowledge about the field, yet they are limited in that the meaning of the information delivered can only be limited for the professional readers.

When only the frequency of emergence of words is considered in the interpretation of the text mining results, the issue of measurement validity arises according to the characteristics of the document

(Saehyeon Kim, 2018). In the case of the frequency of emergence, the most used words turned out to be in the order of institution, establishment, research, development, and performance. However, if they are applied for the analysis as they are, in order to address the issue of excessive interpretation for the formalistic or idiomatic expressions, the inverse document frequency (TF-IDF) is calculated to evaluate the importance, and the unimportant words are excluded from the analysis. In this study, while the word of "institution" has been used 11 times, or the most, if education is mentioned across all of the documents, the importance of the word of "institution" would be decreased since it is a commonly used word. Whereas, the word of "nuclear power" is used less than the word of "institution" for a total of 4 times, yet if it is used intensively in some documents, the keyword of "nuclear power" may be considered to represent a specific topic.

Table 10 illustrates the frequency and the TF-IDF values of the top 30 words based on the frequency of emergence among the nouns extracted via the text mining. Among the top 30 words based on the frequency of emergence, the words with the lowest TF-IDF values turned out to be the research institute (4.5026), talent (4.5026), world (4.5026), solution (4.5026), vision (4.5026), synthesis (4.5026), intelligence (4.5026), industrial revolution (4.5026), convenience (4.5026), and the first (4.5026), among others, respectively.

Table 10. Keywords and Frequency Related to the Introduction of the Equipment and Facility DB

Rank	Word	Frequency of Emergence	TF-IDF	Rank	Word	Frequency of Emergence	TF-IDF
1	Institution	11	6.0120	31	Leading	3	5.5375
2	Establishment	10	6.4185	32	Research institution	2	4.5026
3	Research	10	9.9853	33	Talent	2	4.5026
4	Development	8	6.9200	34	Design	2	5.8889
5	Meditation	8	6.9200	35	World	2	4.5026
6	Nation	7	8.0688	36	Vision	2	4.5026
7	R&D	6	6.9161	37	Synthesis	2	4.5026
8	Science & technology	5	9.2291	38	Small to medium sized	2	5.8889
9	Improvement	5	7.7907	39	Industrial revolution	2	4.5026
10	Development	5	7.7907	40	Intelligence	2	4.5026
11	Korea	4	6.2326	41	Convenience	2	4.5026
12	Support	4	6.2326	42	Pivotal	2	4.5026
13	Future	4	6.2326	43	First	2	4.5026
14	Role	4	6.2326	44	Purpose	2	4.5026
15	Industry	4	7.3833	45	Contribution	2	4.5026
16	Nuclear power	4	11.778	46	Solution	2	4.5026
17	Field	3	5.5375	47	Land	2	5.8889
18	Chemistry	3	8.8333	48	Since	2	4.5026

19	Convergence	3	5.5375	49	Society	2	4.5026
20	Level	3	5.5375	50	Innovation	2	4.5026
21	Industry	3	5.5375	51	Medium sized company	2	5.8889
22	Life	3	6.7539	52	Domestically produced	2	5.8889
23	Competitiveness	3	5.5375	53	Contribution	2	4.5026
24	Safety	3	5.5375	54	Government funded research institute	2	4.5026
25	Supply	3	5.5375	55	Manufacturing innovation	2	5.8889
26	Technology	3	6.7539	56	Long term	2	4.5026
27	People	3	6.7539	57	Astronomy and space science	2	5.8889
28	Related	3	5.5375	58	Global	2	5.8889
29	Policy	3	6.7539	59	Basic science	2	4.5026
30	National science and technology	3	5.5375	60	Tool	1	2.9444

4.2 Seminar DB

As for the type of seminar (IR06-C), the information related to the international cooperation seminar was entered, and a total of 409 cases were collected. A brief examination of the statistically significant contents is as illustrated in **Table 11**.

As a result of analyzing the international cooperation seminar countries, 345 cases were issued by a single country, while 64 cases were issued by two or more countries. In the case of issuance by a single country, it turned out that 305 cases were issued in the Republic of Korea, 10 cases were issued in the People's Republic of China, 5 cases were issued in Singapore and Japan each, 3 cases were issued in the United States, and 2 cases were issued in Canada, Germany, Spain, and Hong Kong each, respectively. Since the Republic of Korea is at the center of cooperation, it has been examined that the most cases were issued in Korea, respectively.

Furthermore, if issued in two or more countries, 11 cases were issued in Korea and France, 7 cases in Korea, the US, and Korea and Russia, 4 in Korea and China, Korea and Japan, and Korea and Switzerland, 3 cases in Korea and the United Kingdom, and Korea, China, and Japan, and 2 cases in Korea and Germany, Korea and Sweden, and Korea and Singapore, respectively. While most were carried out jointly in Korea and other countries, there were also a material each published in cooperation by Japan and Brunei, Hong Kong and China, Vietnam and Thailand, and Malaysia and Australia, respectively.

Table 11. Classification of Countries of the Seminar DB

Classification of country	No. of Units	Classification of country	No. of Units
Republic of Korea	305	Korea, France	11
People's Republic of China	10	Korea, United States of America	7
Singapore	5	Korea, Russia	7
Japan	5	Korea, People's Republic of China	4
United States of America	3	Korea, Japan	4
Canada	2	Korea, Switzerland	4
Germany	2	Korea, United Kingdom	3
Spain	2	Korea, People's Republic of China, Japan	3
Hong Kong	2	Korea, Germany	2
Switzerland	1	Korea, Sweden	2
Sweden	1	Korea, Singapore	2
Belgium	1	Korea, Turkmenistan	1
Czech Republic	1	Korea, Kazakhstan	1
Chile	1	Korea, Vietnam	1
Peru	1	Korea, Poland	1
France	1	Korea, Malaysia	1
The Philippines	1	Korea, Paraguay	1
Indonesia	1	Korea, Hungary	1
		Korea, Canada	1
		Korea, The Netherlands	1
		Korea, India	1
		Korea, Canada, The Philippines	1
		Japan, Brunei	1
		Hong Kong, People's Republic of China	1
		Vietnam, Thailand	1
		Malaysia, Australia	1
Subtotal	345	Subtotal	64
Total			409

As a result of analyzing the international cooperation seminar database institutions of issuance, 88 cases were issued by the Ministry of Foreign Affairs, 28 by the Korea Institute for International Economic Policy, 22 by the Korea Educational Development Institute, 16 by the Korea Maritime Institute, 12 by the Korea Research Institute for Human Settlements, 10 by the National Statistical Office, 9 by the Korea Energy Economics Institute, 8 by Seoul National University, and 7 by the Korea Transport Institute, respectively. Furthermore, 1 case emerged for each of the 133 institutions including the ASEM, DGIST, DIP, GDI, GIST, and the KIET.

Table 12. Institutions of Issuance of the Seminar DB

Rank	Name of institution	No.	Rank	Name of institution	No.
1	Ministry of Foreign Affairs	88	21	KAIST	2
2	Korea Institute for International Economic Policy (KIEP)	28	22	KDI	2
3	Korean Educational Development Institute	22	23	LAFENT	2
4	Korea Maritime Institute	16	24	Ministry of Land, Infrastructure and Transport	2
5	Korea Research Institute for Human Settlements	12	25	National Assembly Research Service	2
6	National Statistical Office	10	26	Dongguk University	2
7	Korea Energy Economics Institute	9	27	Ministry of Justice	2
8	Seoul National University	8	28	Sogang University	2
9	Korea Transport Institute	7	29	Seoul City Hall	2
10	Economics, Humanities and Social Research Council	5	30	Ewha Womans University	2
11	Korea Institute for Industrial Economics & Trade	5	31	Ministry of Information and Communication	2
12	Korea Institute for Health and Social Affairs	5	32	Policy Briefing	2
13	National Youth Policy Institute	4	33	JoongAng Ilbo	2
14	Ministry of Culture, Sports and Tourism	3	34	Pohang University of Science and Technology	2
15	Yonsei University	3	35	Korea Institute of Construction Technology	2
16	Korea Institute of Intellectual Property	3	36	Korea Foundation for the Advancement of Science and Creativity	2
17	Korea Construction Newspaper	3	37	Korean Society for Railway	2
18	Korea Institute of Science and Technology Information	3	38	Ministry of the Interior and Safety	2
19	Korea Institute for Curriculum and Evaluation	3	39	ASEM, DGIST, DIP, GDI, GIST, KIET Korea Institute for Industrial Economics & Trade, and others	1 each (133)
20	Hanyang University	3			

   As a result of analyzing the number of institutions hosting the international cooperation seminars, it turned out that the highest number of cases was 270 cases carried out by a single institution alone, while 106 cases were jointly carried out by two institutions, and 21 cases were carried out jointly by three institutions, respectively.

Table 13. Other DB Seminars of the International Research Cooperation – Number of Host Institutions

Serial No.	Name of institution	Target Equipments (Units)
1	Korea Institute for Advanced Study	1
2	Korea Institute of Science and Technology	2
3	Korea Institute of Radiological & Medical Sciences	2
4	Korea Internet & Security Agency	7
5	Institute for Advanced Engineering	18
6	Korea Institute of Construction Technology	1
7	Korea Institute of Industrial Technology	23
8	Korea Atomic Energy Research Institute	330
9	Korea Advanced Institute of Science and Technology	13
10	Korea Institute of Machinery and Materials	15
11	Korea Basic Science Institute	1
12	National AI Research Institute	8
13	Korea Astronomy and Space Science Institute	1
14	Korea Research Institute of Standards and Science	5
15	Korea Aerospace Research Institute	18
16	Korea Research Institute of Chemical Technology	9
17	Gwangju Institute of Science and Technology	19
18	Korea Electrotechnology Research Institute	2
19	National Information Society Agency	6

As a result of analyzing the year of issuance of the 409 cases of the international cooperation seminars, it seems that the most international cooperation seminars were held in 2016 with 39 cases, and the number fell steeply to 3 cases in 2020, most likely due to the influence of the COVID-19 overall.

Table 14. Number of the Years of Hosting and Issuance for the Seminar DB

Classification	No.	Classification	No.
In or before 2000	2	2010	24
2000	3	2011	33
2001	2	2012	16
2002	9	2013	22
2003	17	2014	32
2004	25	2015	31
2005	18	2016	39
2006	7	2017	26
2007	10	2018	27

| 2008 | 25 | 2019 | 22 |
| 2009 | 16 | 2020 | 3 |
| Total | | | 409 |
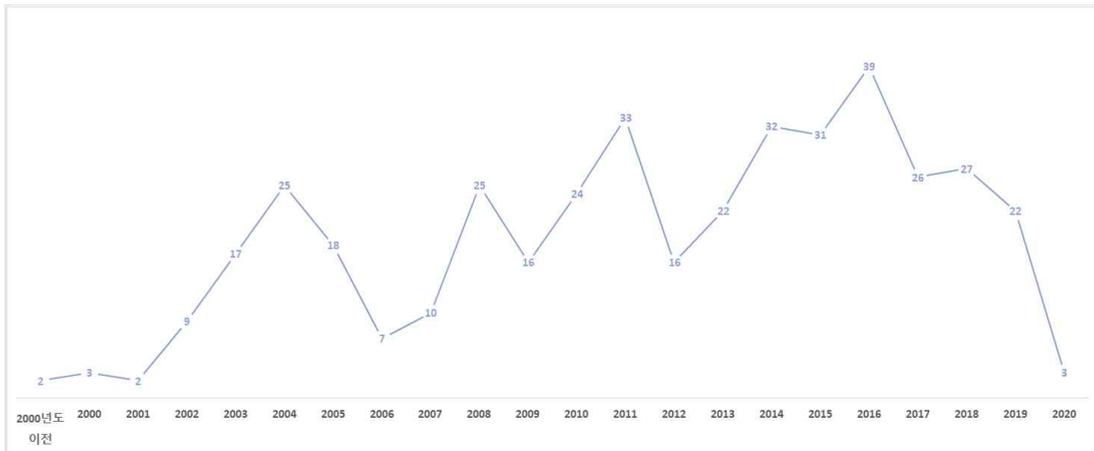
Fig. 1. Number of the Years of Hosting and Issuance for the Seminar DB

Keywords for the introduction of the international cooperation seminar were derived and analyzed. To examine which keywords emerged the most, the frequency of the emergence of keywords was examined. This is a frequency table illustrating the top 30 keywords which emerged in this manner.

As a result of the analysis, among the keywords which emerged for the introduction of international research cooperation and other programs, the keywords with a high frequency of emergence were seminar (359), discussion (127), expert (125), Korea (114), hosting (111), topic (109), proceeding (82), plan (75), cooperation (72), seeking (70), and presentation (61), among others, respectively.

Table 15. Analysis of the Keywords for the Introduction of Seminar

No.	Word	Frequency	Percentage	No.	Word	Frequency	Percentage
1	Seminar	359	3.51	16	People's Republic of China	51	0.50
2	Discussion	127	1.24	17	Current status	51	0.50
3	Expert	125	1.22	18	International	50	0.49
4	Korea	114	1.12	19	Attendance	49	0.48
5	Host	111	1.09	20	Japan	48	0.47
6	Topic	109	1.07	21	United States of America	47	0.46
7	Proceeding	82	0.80	22	Field	47	0.46
8	Plan	75	0.73	23	Share	47	0.46
9	Cooperation	72	0.70	24	Joint	46	0.45
10	Seeking	70	0.68	25	Both counties	44	0.43
11	Announcement	61	0.60	26	Development	44	0.43

12	Policy	61	0.60	27	Nation	44	0.43
13	Research	55	0.54	28	Debate	41	0.40
14	Related	54	0.53	29	Purpose	41	0.40
15	Domestic	54	0.53	30	Technology	39	0.38

In **Table 15**, the keywords with a high frequency of emergence were derived based on the introduction of the international cooperation seminar, and major keywords were verified. However, such results, which simply demonstrate with a focus on the frequency, are meaningful in that they demonstrate the overall keywords to the public who have almost no knowledge about the field. Yet, they are limited in that the meaning of the information delivered is restricted for the professional readers.

When only the frequency of the emergence of words is considered in the interpretation of the text mining results, the issue of measurement validity arises according to the characteristics of the document (Saehyeon Kim, 2018). In the case of the frequency of emergence, it turned out that the most used words were program, Korea, case, field, health insurance, policy, education, and country. However, if they are applied for the analysis as they are, in order to address the issue of excessive interpretation for the formalistic or idiomatic expressions, the inverse document frequency (TF-IDF) is calculated to evaluate the importance, and the unimportant words are excluded from the analysis. In this study, while the word of "seminar" has been used 359 times, or the most, the importance of the word of "seminar" would be decreased since it is a word pertaining to the seminar DB. Whereas, the word of "Korea" is used less than the word of "program" for a total of 114 times, yet if it is used intensively in some documents, the keyword of "Korea" may be considered to represent a specific topic.

Table 16 illustrates the frequency and the TF-IDF values of the top 40 words based on the frequency of emergence among the nouns extracted via the text mining. They turned out to be world (98.27), debate (97.52), member country (96.50), direction (93.51), future (88.57), international seminar (86.71), response (86.18), invitation (85.21), Germany (82.70), energy (82.70), development (82.63), development (80.66), and experience (79.47), respectively.

Table 16. Frequency and TF-IDF of the Emergence of Keywords for the Seminar DB. Based on the Top 40 Words

Rank	Word	Frequency of Emergence	TF-IDF	Rank	Word	Frequency of Emergence	TF-IDF
1	Korea	114	169.13	21	Share	47	108.22
2	Expert	125	162.21	22	Japan	48	107.13
3	Discussion	127	161.45	23	Technology	39	106.09
4	Topic	109	157.12	24	Attendance	49	105.10
5	Host	111	153.34	25	Joint	46	104.81
6	Cooperation	72	142.06	26	Development	44	103.51
7	Proceeding	82	141.51	27	Seminar	359	100.37

8	Plan	75	135.86	28	World	39	98.27
9	Policy	61	127.14	29	Debate	41	97.52
10	Announcement	61	125.96	30	Member country	34	96.50
11	Seeking	70	124.74	31	Direction	38	93.51
12	Research	55	124.02	32	Future	33	88.57
13	Domestic	54	119.31	33	International seminar	34	86.71
14	Current status	51	116.20	34	Response	29	86.18
15	People's Republic of China	51	115.00	35	Invitation	33	85.21
16	United States of America	47	113.05	36	Germany	25	82.70
17	Field	47	110.57	37	Energy	25	82.70
18	International	50	109.38	38	Development	32	82.63
19	Both countries	44	108.28	39	Building	28	80.66
20	Nation	44	108.28	40	Experience	28	79.47
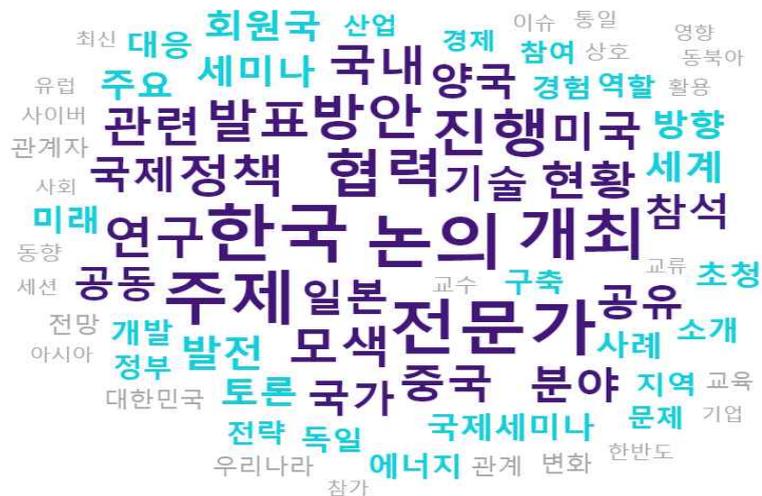
4.3 Consortium DB

As for the type of the international cooperation consortium (IR06-A), the consortium related information related to the international cooperation was collected, and a total of 14 consortiums were collected. In the case of the consortiums related to the international cooperation, the largest amount of information hosted in Korea (7 cases) was collected. However, in the case of the host countries, they turned out to be the Netherlands, Korea, the United States, Vietnam, France, Finland, the Philippines, and Vietnam, among others, respectively.

Table 17. Classification of Countries for the Consortium DB

Classification of country	No. of Units	Classification of country	No. of Units
CA	1	KR	7
DK	1	US	3
JP	1	VN	1
Total	14		

Table 18. Location of the Consortium DB

Classification of country	No. of Units	Classification of country	No. of Units
Amsterdam, The Netherlands	1	Ho Chi Minh, Vietnam	1
Seoul, Republic of Korea	1	Tokyo, Japan	1
Graduate School of Public Health, Seoul National University, Republic of Korea	1	Paris, France	1
United Nations Headquarters, New York, USA	1	Helsinki, Finland	1
(Not entered)	5	Manila, The Philippines	1
Total	14		

Most of such international cooperation consortiums were hosted and proceeded by a single institution (12 cases).

Table 19. Host Institution of the Consortium DB

Classification of country	No. of Units
1 institution	12
4 or more institutions	1
(Not entered)	1
Total	14

Based on the "introduction" of the international cooperation consortium, the words with a high frequency of emergence were derived, and major keywords were verified. **Table 20** illustrates a summary of the keywords which emerge frequently in the introduction of the consortium. The keywords with a highest frequency of emergence turned out to be "research (10 times)," "consortium (7 times)," "ocean (4 times)," "genom (4 times)," "university (4 times)," and "information (3 times)," among others, respectively.

Meanwhile, the TF-IDF values were verified to reduce the importance of the clichés which frequently emerge in all of the DBs. Among the top 40 words based on frequency of emergence, the words

with the lowest TF-IDF values turned out to be stakeholder (3.8918), network (3.8918), specialization (3.8918), structure (3.8918), North America (3.8918), education (3.8918), and cooperation (3.8918), among others, respectively.

Table 20. Frequency and TF-IDF of the Emergence of Keywords for the Consortium DB. Based on the Top 40 Words

Rank	Word	Frequency of Emergence	TF-IDF	Rank	Word	Frequency of Emergence	TF-IDF
1	Research	10	10.5562	21	Share	2	4.6213
2	Consortium	7	6.1618	22	Support	2	3.8918
3	Ocean	4	6.1618	23	Stakeholder	2	3.8918
4	Genom	4	5.9311	24	Network	2	3.8918
5	University	4	5.8377	25	Specialization	2	3.8918
6	Information	3	5.8377	26	Structure	2	3.8918
7	Provision	3	5.5962	27	North America	2	3.8918
8	Domestic	3	5.2781	28	Education	2	3.8918
9	International	3	5.2781	29	Cooperation	2	3.8918
10	Use	3	5.2781	30	Promotion	2	3.8918
11	World	2	5.2781	31	Scientist	2	3.8918
12	Cancer	2	5.2781	32	COVID-19	2	3.8918
13	Disease	2	5.2781	33	Korean genom	2	3.8918
14	Institution	2	5.2781	34	Organization	2	3.8918
15	Service	2	5.2781	35	Company	2	3.8918
16	Procurement	2	5.2781	36	Lead	2	3.8918
17	Strange	2	5.2781	37	Territory	2	3.8918
18	Communication	2	5.2781	38	Library of Korean Studies	2	3.8918
19	Use	2	4.6213	39	Adjustment	2	3.8918
20	Analysis	2	4.6213	40	Registry	1	2.6391

4.4 Program DB

As for the type of program (IR06-D), the information related to the international cooperation program was entered, and a total of 21 cases were collected. A brief examination of the statistically significant contents is as illustrated in **Table 21**.

As a result of analyzing the countries cooperating with Korea for the international cooperation program, they turned out to be 7 countries in Asia (Pakistan, Indonesia, the Philippines, Laos, and across Asia, etc.), 5 others (worldwide and developing countries, etc.), 3 countries in South America (Colombia, Latin America, Peru), 2 in Africa (Jordan), and 2 countries in Asia Pacific, among others, respectively. The cooperation with Asian countries turned out to be high, and the

program cooperation and exchanges with North America and Europe turned out to be rather low.

Table 21. Number of the Countries of Program Cooperation

Classification	No.	Cooperation Nation
North America	1	United States of America
South America	3	Latin America, Columbia, Peru
Asia	7	Pakistan, Indonesia, The Philippines, Laos, across Asia
Europe	1	Italy
Africa	2	Jordan
Asia·Pacific	2	Asia·Pacific
Others	5	Developing country, etc.
Total	21	

As a result of analyzing the number of institutions of issuance proceeding with the international cooperation program, they turned out to be 7 for the KOICA, which is an international cooperation institution, 3 for the Science and Technology Policy Institute, and 2 for Korea International Cooperation Agency and the Ministry of Health and Welfare each, among others, respectively.

Table 22. Number of the Institutions of Issuance for the Program DB

Classification	No. of Units	Classification	No. of Units
KOICA	7	National Health Insurance Service	1
Science and Technology Policy Institute	3	Ministry of Foreign Affairs	1
Korea International Cooperation Agency	2	Soongsil University	1
Ministry of Health and Welfare	2	K-Water	1
SHRDC	1	Professional Graduate School of Cultural Heritage, Korea National University of Cultural Heritage	1
National Institute for International Education, Ministry of Education	1		
Total	21		

The keywords for the introduction of international cooperation program were derived and analyzed. To examine which keywords emerged the most, the frequency of the emergence of keywords was examined. This is the frequency table demonstrating the top 30 selected amnog the keywords emerged in such manner.

As a result of the analysis, among the keywords which emerged in the introduction of international research cooperation and other programs, the keywords with a high frequency of emergence turned

out to be program (12 times), Korea (8 times), case (6 times), field, health insurance, policy, education, and country (5 times each), among others, respectively. Accordingly, it was verified that such keywords as health insurance, policy, and education were frequently mentioned except for the words of program, case, and field. Furthermore, among the top 30, e-government, developing country, public official, expert, share, oriental medicine, cooperation, research, science and technology policy, and training program, among others, were verified.

Table 23. Analysis of the Keywords for the Introduction of Program

No.	Word	Frequency	Percentage	No.	Word	Frequency	Percentage
1	Program	12	2.71	16	Target	4	0.90
2	Korea	8	1.81	17	Jordan	4	0.90
3	Case	6	1.35	18	Implementation	4	0.90
4	Field	5	1.13	19	Territory	4	0.90
5	Health insurance	5	1.13	20	Proceeding	3	0.68
6	Policy	5	1.13	21	Invitation	3	0.68
7	Education	5	1.13	22	Share	3	0.68
8	Nation	5	1.13	23	Experience	3	0.68
9	Procurement	4	0.90	24	Oriental medicine	3	0.68
10	e-government	4	0.90	25	Understanding	3	0.68
11	Provision	4	0.90	26	Cooperation	3	0.68
12	Developing country	4	0.90	27	Indonesia	3	0.68
13	Comparison	4	0.90	28	Research	3	0.68
14	Public official	4	0.90	29	Science and technology policy	3	0.68
15	Expert	4	0.90	30	Training program	3	0.68

In **Table 23**, the keywords a high frequency of emergence were derived based on the program introduction for the international cooperation program, and major keywords were verified. However, such results, which simply demonstrate with a focus on the frequency, are meaningful in that they demonstrate the overall keywords to the public who have almost no knowledge about the field. Yet, they are limited in that the meaning of the information delivered is restricted for the professional readers.

When only the frequency of the emergence of words is considered in the interpretation of the text mining results, the issue of measurement validity arises according to the characteristics of the document (Saehyeon Kim, 2018). In the case of the frequency of emergence, it turned out that the most used words were program, Korea, case, field, health insurance, policy, education, and country, among others, respectively. However, if they are applied for the analysis as they are, in order to address the issue of excessive interpretation for the formalistic or idiomatic expressions, the inverse document frequency (TF-IDF) is calculated to evaluate the importance, and the unimportant words are excluded from the analysis. In this study, while the word of "program" has been used

12 times, or the most, the importance of the word of "program" would be decreased since it is a word commonly used. Whereas, the word of "health insurance" is used less than the word of "program" for a total of 5 times, yet if it is used intensively in some documents, the keyword of "health insurance" may be considered to represent a specific topic.

Table 24 illustrates the frequency and the TF-IDF values of the top 40 words based on the frequency of emergence among the nouns extracted via the text mining. Among the top 40 words based on the frequency of emergence, the words associated with the low TF-IDF values turned out to be invitation, proceeding, share, experience, purpose, understanding, and cooperation with 5.838 each, respectively.

Table 24. Frequency and TF-IDF of the Emergence of Keywords for the Program DB. Based on the Top 40 Words

Rank	Word	Frequency of Emergence	TF-IDF	Rank	Word	Frequency of Emergence	TF-IDF
1	Health insurance	5	9.730	21	Target	4	6.633
2	Jordan	5	9.406	22	Implementation	4	6.633
3	Territory	4	9.406	23	SME	2	6.089
4	Oriental medicine	3	9.134	24	Policy conversation	2	6.089
5	Indonesia	3	9.134	25	Latin America	2	6.089
6	Case	6	8.611	26	Developing country	2	6.089
7	Field	5	8.291	27	University education	2	6.089
8	Policy	5	8.291	28	WHO	2	6.089
9	Education	5	8.291	29	Urban development	2	6.089
10	e-government	4	7.784	30	Training	2	6.089
11	Comparison	4	7.784	31	National development strategy	2	6.089
12	Public official	4	7.784	32	Diplomat	2	6.089
13	Korea	8	7.721	33	Platform	2	6.089
14	Nation	5	7.175	34	Invitation	3	5.838
15	Research	3	7.054	35	Proceeding	3	5.838
16	Science and technology policy	3	7.054	36	Share	3	5.838
17	Program	12	6.715	37	Experience	3	5.838
18	Procurement	4	6.633	38	Purpose	3	5.838
19	Provision	4	6.633	39	Understanding	3	5.838
20	Developing country	4	6.633	40	Cooperation	1	5.838

4.5 Workshop DB

As for the type of workshop (IR06-E), the information related to the international cooperation

program was entered, and a total of 36 cases were collected. A brief examination of the statistically significant contents is as illustrated in **Table 25**.

As a result of analyzing the number of the institutions of issuance carrying out the international cooperation workshops, 7 were by the Korea Institute of Ocean Science and Technology, which is an international cooperation institution, 5 by the National Statistical Office and the National Research Foundation of Korea, 4 by the Korea Maritime Institute, and 3 by the Korea Maritime Science Joint Research Center and the State Oceanic Administration of China each, among others, respectively.

Table 25. Number of the Institutions of Issuance for the Workshop DB

Classification	No. of Units	Classification	No. of Units
Korea Institute of Ocean Science and Technology	7	Korea-Latin America Marine Science and Technology Joint Research Center	2
National Statistical Office	5		
National Research Foundation of Korea	5	Graduate School of International Policy, KDI	1
Korea Maritime Institute	4	Korea-China Oceanic Science Joint Research Center	1
State Oceanic Administration of China	3	Intergovernmental Oceanic Studies Committee	1
Korea-China Oceanic Science Joint Research Center	3	Ministry of Oceans and Fisheries of Korea	1
KCDC	2	Polar Research Center of China	1
Total	36		

As a result of analyzing the countries cooperating with Korea for the international cooperation program, 7 were with China, 2 with the East Asia, China, and South America each, and 10 with the others, among others, respectively. It turned out that most of the workshop programs were operated in cooperation with two or more countries, rather than cooperating with only a single country.

Table 26. Number of the Countries Cooperating on Workshop

Classification of country	No. of Units	Classification of country	No. of Units
People's Republic of China	16	Japan	1
East Asia	2	Asia·Pacific	1
People's Republic of China·South America	2	People's Republic of China·Japan	1
People's Republic of China·Russia	1	Others	10
People's Republic of China·Northern Europe	1	-	-
Total			35

The keywords for the introduction of the international cooperation program were derived and analyzed. To examine which keywords emerged the most, the frequency of the emergence of keywords was examined. This is the frequency table illustrating the top 30 keywords which emerged in such manner.

As a result of the analysis, among the keywords which emerged in the introduction of international research cooperation and other programs, the keywords with a high frequency of emergence turned out to be workshop (27), presentation (17), topic (15), expert (14), research (13), and proceeding (12), and cooperation (11), among others, respectively. Besides which, such words as marine science and technology, arctic, ocean, and marine environment emerged frequently, which is verified to be due to the inclusion of the institutions which issued the workshop DBs such as the Korea Institute of Ocean Science and Technology, Korea Maritime Institute, and the Korea Maritime Science Joint Research Center, respectively.

Table 27. Introduction of the Workshop DB

No.	Word	Frequency	Percentage	No.	Word	Frequency	Percentage
1	Workshop	27	3.35	16	North Pole	7	0.87
2	Announcement	17	2.11	17	Korea	7	0.87
3	Topic	15	1.86	18	Share	6	0.74
4	Expert	14	1.73	19	Ocean	6	0.74
5	Research	13	1.61	20	People's Republic of China	6	0.74
6	Proceeding	12	1.49	21	Oceanic environment	6	0.74
7	Cooperation	11	1.36	22	Direction	5	0.62
8	Both countries	9	1.12	23	Yellow Sea	5	0.62
9	Implementation	9	1.12	24	Climate change	5	0.62
10	Field	8	0.99	25	Development	5	0.62
11	Host	8	0.99	26	Latin America	5	0.62
12	Exchange	8	0.99	27	Korea-China	5	0.62
13	Discussion	8	0.99	28	Protection	5	0.62
14	Related	8	0.99	29	Performance achievement	5	0.62
15	Marine science and technology	7	0.87	30	Nation	5	0.62

In **Table 27**, the keywords with a high frequency of emergence were derived based on the program introduction for the international cooperation program, and major keywords were verified. However, such results, which simply demonstrate with a focus on the frequency, are meaningful in that they demonstrate the overall keywords to the public who have almost no knowledge about the field. Yet, they are limited in that the meaning of the information delivered is restricted for the professional readers.

When only the frequency of the emergence of words is considered in the interpretation of the

text mining results, the issue of measurement validity arises according to the characteristics of the document (Saehyeon Kim, 2018). In the case of the frequency of emergence, it turned out that the most used words were workshop, presentation, topic, expert, research, and progress, among others, respectively. However, if they are applied for the analysis as they are, in order to address the issue of excessive interpretation for the formalistic or idiomatic expressions, the inverse document frequency (TF-IDF) is calculated to evaluate the importance, and the unimportant words are excluded from the analysis. In this study, while the word of "workshop" has been used 27 times, or the most, the importance of the word of "workshop" would be decreased since it is a word which provides a foundation fo the relevant database. Whereas, the word of "arctic" is used less than the word of "workshop" for a total of 7 times, yet if it is used intensively in some documents, the keyword of "workshop" may be considered to represent a specific topic.

Table 28 illustrates the frequency and the TF-IDF values of the top 40 words based on the frequency of emergence among the nouns extracted via the text mining. Among the top 40 words based on the frequency of emergence, the words with the lowest TF-IDF values turned out to be technology (10.75), share (10.75), change (9.94), current status (9.94), joint (9.94), development (9.87), and country (9.87), among others, respectively.

Table 28. Frequency and TF-IDF of the Emergence of Keywords for the Workshop DB. Based on the Top 40 Words

Rank	Word	TF-IDF	Rank	Word	TF-IDF
1	North Pole	20.23	21	Host	12.03
2	Research	16.65	22	Related	12.03
3	Field	15.79	23	Ocean	11.84
4	Marine science and technology	15.38	24	Modelling	11.56
5	Expert	15.38	25	Online survey	11.56
6	Announcement	14.88	26	Books	11.56
7	Both countries	14.74	27	Development	11.56
8	Implementation	14.74	28	Direction	10.99
9	Workshop	14.55	29	Yellow Sea	10.99
10	Latin America	14.45	30	Climate change	10.99
11	Remote sensing	14.33	31	Korea-China	10.99
12	Proceeding	14.23	32	Protection	10.99
13	Topic	14.17	33	Performance achievement	10.99
14	Cooperation	14.09	34	Technology	10.75
15	Korea	13.82	35	Share	10.75
16	People's Republic of China	13.18	36	Change	9.94
17	Oceanic environment	13.18	37	Current status	9.94
18	Exchange	13.10	38	Joint	9.94
19	Discussion	13.10	39	Development	9.87

| 20 | Use | 12.42 | 40 | Nation | 9.87 |

4.6 Symposium DB

As for the type of international cooperation symposium, the information related to symposium related to the international cooperation was collected, and a total of 950 cases were developed. In the case of the international cooperation related consortium collected, the most information hosted in Korea (831 cases) was collected, with 864 cases focused on a single country, while 80 cases were surveyed for the classification of two or more countries.

Table 29. Classification of Country for the Symposium DB

Classification of country	No. of Units	Classification of country	No. of Units
CL	1	AU, KR	1
CN	1	FR, DE, KR	1
DE	1	FR, KR, DE, DK	1
FR	3	IT, KR	1
GB	1	KR, AU	1
IN	1	KR, CH	7
IS	1	KR, CN	9
IT	1	KR, DE	2
JP	11	KR, FR	6
KR	831	KR, ID	1
MN	1	KR, IT	3
NP	1	KR, JP	15
SE	2	KR, JP, CN	12
SG	1	KR, MY	1
TH	2	KR, RU	1
US	5	KR, SE	1
		KR, SG	2
		KR, US	8
-	-	KR, US, FR	4
		KR, ZA	1
		MN, KR	1
		TW, US	1
Total	864	Total	80

Most of such international cooperation consortiums were hosted and proceeded by a single institution (712 cases).

Table 30. Host Institutions for the Consortium DB

Classification of country	No. of Units
1 institution	712
2 or more institutions	230
Not entered	2
Total	944

In the case of the international cooperation symposium, as a result of analyzing the year of issuance for the remaining 574 cases excluding the 370 cases of non-entry, it seems that the most international cooperation symposiums were held in 2019 with 80 cases, and the number fell steeply to 10 cases in 2020, most likely due to the influence of the COVID-19 overall.
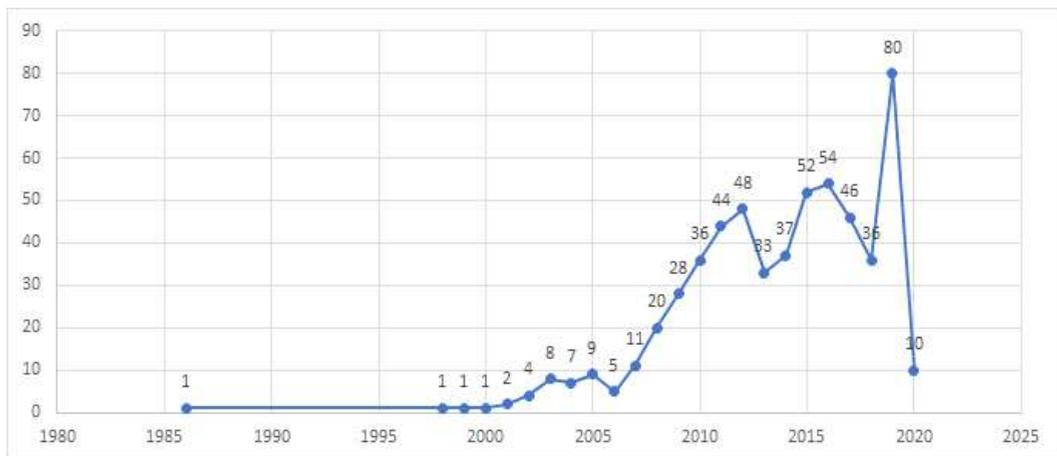
Fig. 2. Year of Issuance for the Symposium DB

Based on the "introduction of institutions" for the international cooperation symposium, the words with a high frequency of emergence were derived, and major keywords were verified. **Table 31** illustrates a summary of the key words which emerge frequently in the introduction of symposium. The keywords with a highest frequency of emergence turned out to be "symposium (779 times)," "topic (226 times)," "discussion (191 times)," "presentation (183 times)," "host (182 times)," "expert (179 times)," and "proceeding (173 times)," among others, respectively.

Meanwhile, the TF-IDF values were verified to reduce the importance of the clichés which frequently emerge in all of the DBs. Among the top 40 words based on the frequency of emergence, the words with the lowest TF-IDF values turned out to be topic (341.62), presentation (311.77), host (310.07), discussion (309.25), proceeding (308.50), expert (303.91), and research. (285.49), among others, respectively.

Table 31. Keywords and Frequency Related to the Introduction of the Symposium DB

Rank	Word	Frequency of Emergence	TF-IDF	Rank	Word	Frequency of Emergence	TF-IDF
1	Topic	226	341.62	21	Place	80	197.6023
2	Announcement	183	311.77	22	Future	74	196.0868
3	Host	182	310.07	23	Domestic	75	194.3236
4	Discussion	191	309.25	24	Plan	72	188.6377
5	Proceeding	173	308.50	25	Procurement	74	187.6204
6	Expert	179	303.91	26	Current status	64	177.8581
7	Research	138	285.49	27	Development	66	176.9192
8	Etc.	148	281.94	28	People's Republic of China	60	175.6472
9	Share	133	264.33	29	Performance achievement	59	164.9891
10	Korea	120	262.26	30	Nation	53	161.9302
11	Domestic and foreign	127	261.66	31	Cooperation	56	161.741
12	Japan	111	248.01	32	Participation	56	158.6
13	Field	104	238.80	33	Invitation	54	153.9266
14	This time	106	231.6647	34	Case	51	152.4558
15	Debate	103	231.1687	35	Education	47	151.7423
16	Seeking	98	221.947	36	Direction	51	151.382
17	International	91	218.1111	37	Professor	44	151.2843
18	Related	83	209.325	38	East Asia	46	149.774
19	World	82	206.803	39	Each country	51	149.3001
20	Symposium	779	198.3997	40	Between	50	148.4138

5. Discussion

In the case of the international cooperation DB, the programs and workshops were hosted to introduce or educate on the social and cultural characteristics, policies, and development directions for Korea's policies, technology, education, and research via cooperation with the Asian region and developing countries, among others.

As a trend of the international cooperation related to the equipment / facility, the average number of target equipments turned out to be 25.32 units, and the Korea Atomic Energy Research Institute turned out to be carrying out the most equipment / facility related cooperation with 330 points, respectively. In particular, it turned out that most of the institutions carrying out the international cooperation in connection with equipment / facility are located in Daejeon.

Examining the trends of the international cooperation for the consortium DB, they turned out

to be research, consortium, ocean, and genom, among others, and through which, it is apparent that the fields of consortium hosted via international cooperation are ocean, genom, cancer, disease, and communication, among others. Meanwhile, in the case of the symposiums hosted via international cooperation, one was hosted by a single institution, and it turned out that it was hosted the most in 2019. Furthermore, as a result of analyzing the current status of recent seminars, a trend of 20 to 30 seminars were demonstrated consistently, yet only 3 were hosted in 2020, respectively. Because of the COVID-19 situation, no face-to-face seminar would have been allowed, and difficulties in carrying out exchanges with the international community must have been apparent. There is also a possibility that the atmosphere of concentrating on the domestic situation rather than pursuing cooperation with the international community to break through the COVID-19 may have been predomin ant.

Accordingly, it would be necessary to host international cooperation programs, seminars, and workshops, among others, with a focus on the topics to restore the trend of international cooperation as in the past, and also recover from the pandemic situation.

6. Conclusion and Recommendation

In this study, the international research cooperation and other DB workshops, programs, consortiums, equipments and facilities, symposium, institutions of seminar DB, introduction, and the current status of national cooperation, among others, which were developed for approximately 4 years since 2017, were analyzed. While there were differences in the analysis according to the characteristics of each database, the analysis was mainly conducted to derive keywords via the text mining analysis of cooperative institutions or the number of institutions, host institutions (institution of issuance), cooperati ve countries, year of issuance, and each DB introduction. The results of the analysis for each DB are as follows.

First, as a result of analyzing the current status of the type of equipment / facility DB, the equipment / facility related information of the research institutes related to the international cooperation was entered, and a total of 19 cases were collected. They were retained by the Korea Institute for Advanced Study and the Korea Institute of Science and Technology, among others, and the most of those owning the equipments and facilities turned out to be located in Daejeon (10 cases). In the case of target equipments, the Korea Atomic Energy Research Institute had the highest score of 330 points, and the average target equipment was 25.32 units, respectively. While the word of "institution" is used the most for 11 times, the word of "nuclear power" is used 4 times across all documents, which is less than the word of "institution," yet if it is used intensively in some documents, the keyword of "nuclear power" turned out to represent a specific topic.

Second, as a result of analyzing the current status of the international cooperation seminar, the countries which hosted the international cooperation seminar turned out to be such various countries as Korea, China, Singapore, Japan, the United States, Canada, Germany, Spain, Hong Kong, and Switzerland, among others, respectively. In particular, in the case of jointly hosting, France turned out to have the most with 11 cases. Furthermore, as a result of analyzing the institutions of issuance

of the international cooperation seminar database, it turned out that the Ministry of Foreign Affairs had 88, the Korea Institute for International Economic Policy had 28, and the Korea Educational Development Institute had 22, among others, respectively. It also seems that 39 cases, or the most, were hosted in 2016 where the international cooperation seminar was hosted, and the number fell steeply to 3 cases in 2020, most likely due to the influence of the COVID-19 overall.

Third, as a result of analyzing the current status of consortium types, a total of 14 consortiums were collected. The keywords with a highest frequency of emergence turned out to be "research (10 times)," "consortium (7 times)," "marine (4 times)," "genom (4 times)," "university (4 times)," and "information (3 times)," among others, respectively.

Fourth, as a result of analyzing the current status of the international cooperation program, and as a result of analyzing the countries cooperating with Korea, the cooperation with Asian countries turned out to be high, and the program's cooperative exchanges with North America and Europe turned out to be somewhat low. As a result of analyzing the number of institutions of issuance which proceed with the program, the KOICA, which an international cooperation institution, has 7, the Science and Technology Policy Institute has 3, and the Korea International Cooperation Agency and the Ministry of Health and Welfare have 2 each, respectively. Furthermore, while the word of "program" is used for 12 times, or the most, the importance of the word of "program" is decreasing because it is a commonly used word. Whereas, the word of "health insurance" is used less than the word of "program" for a total of 5 times, yet if it is used intensively in some documents, the keyword of "health insurance" may be considered to represent a specific topic.

Fifth, as a result of analyzing the status of international cooperation workshop, it turned out that most of the workshop programs were operated in cooperation with two or more countries rather than with only a single country. While the word of "workshop" is used for 27 times, or the most, it may considered that the importance of the word of "workshop" is decreasing because it is a word which provides the foundation for the relevant database. Where, the word of "arctic" is used less than the word of "workshop" for a total of 7 times, yet if it is used intensively in some documents, the keyword of "workshop" may be considered to represent a specific topic.

Sixth, as for the type of international cooperation symposium, the symposium related information related to the international cooperation was collected, and a total of 950 cases were developed. In the case of the international cooperation related consortium collected, the most information hosted in Korea (831 cases) was collected, with 864 cases focused on a single country, while 80 cases were surveyed for the classification of two or more countries. In the case of the international cooperation symposium, as a result of analyzing the year of issuance for the 574 cases, the most international cooperation symposiums were hosted in 2019 with 80 cases, and they would most likely have been influenced by the COVID-19 overall. Furthermore, the keywords with a highest frequency of emergence turned out to be "symposium (779 times)," "topic (226 times)," "discussion (191 times)," "presentation (183 times)," "host (182 times)," "expert (179 times)," and "proceeding (173 times)," among others, respectively.

Therefore, the level of cooperation across the international research cooperation seminars, workshops, consortiums, technology, and programs, among others, is still low for the 20 years of international research cooperation, and hence, Korea would need to strengthen its overall capabilities for the

international cooperation by facilitating the international research cooperation moving forward. Further more, since advanced countries in the west are central to the international research cooperation, to strengthen the international research cooperation with and for the developing countries including Asian countries in the future, conferences would need to be hosted and education would also need to be provided in connection with the provision of incentives for the researchers of advanced countries to share the information and technology with East Asian countries or developing countries, as well as the contribution they can make to helping address the economic inequity across the world, among others.

It is expected that the results of this study may be utilized as the basic data for examining and understanding the current status of the international research cooperation by country across the fields such as consortium, workshop, seminar, and program, among others, and making contribution to facilitating the international technology cooperation and the international research cooperation for Korea and developing countries moving forward.

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