A Study on the Researcher's Perception Survey for Facilitating International Joint Research

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ABSTRACT

In this study, we wanted to investigate and analyze the current status of international joint research conducted on researchers who have actually conducted or are doing international joint research and to identify difficulties in promoting international joint research based on this study and propose ways to promote future international joint research. As a result, autonomy of research subjects needs to be guaranteed for the revitalization of international joint research, establishment of international joint research guidelines and contract legal infrastructure, simplification and unification of administrative work system and supplementation of performance-related regulations will be necessary.

1. Introduction

As science and technology have incrementally evolved more complex, convergent and larger, the importance of joint research for reducing the cost and risk of research and development and mutually complementing technologies is increasing. Over the recent years, as the pace of technological innovation has accelerated and the globalization of science and technology has further intensified, it has become increasingly difficult to create world-class research results with only a single nation's technical resources and research personnel, thereby raising the need for international joint research for effectively introducing advanced technologies from overseas. To overcome such limitations, nations around the world are increasingly collaborating with other countries and also expanding their collaborative projects with international organizations and research institutes.

International joint research is a form of research performed jointly with research and development funds, human resources, facilities, equipment, and information, which are required for the research tasks whose principal subjects are located in multiple countries. Through which, each party can pursue a mutual win-win strategy by maximizing synergy by combining with the strengths of the other party, while it is also possible to enhance the national technological competitiveness through

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this process nationally speaking (Yang, 2011).

Korea has also paid increasing attention to the international joint research as a means to strengthen its national competitiveness in science and technology by overcoming the internal limits of independent research and development and efficiently utilizing foreign resources in tandem with advanced science and technology. The international joint research project, which began in 1985 with the aim of overcoming the limits of domestic research and development capabilities via joint research with foreign countries and acquiring foreign advanced technology promptly, is representative of internationalization efforts. According to the analytical data on the current status of the national research and development survey and report in 2017, 623 international joint research projects were conducted in 2017, and most of the international joint and consigned research projects were conducted by the Ministry of Science, Technology and Information and the Ministry of Trade, Industry and Energy, and the major countries of collaboration were in the order of the United States, China, France, Germany, and the United Kingdom, respectively.

Such international joint research is now one of the essential forms of research to resolve the needs of the international society. However, international joint research has difficulties on the other aspect of the domestic joint research in that it is a research conducted by and between the parties located in remote locations with different legal systems beyond the borders.

The goal of this study is to investigate and analyze the current status of the international joint research conducted by the researchers who have actually conducted or are engaged in the international joint research, based on which to identify difficulties involved in implementing the international joint research and propose the ways of facilitating the international joint research in the future.

2. Theoretical Background

2.1 Previous Studies

Studies on the international joint research have been conducted since the early 1990s, and there have been many researches on the results of the international joint research, researches on trend analysis, development of measures for the facilitation and improvement measures, as well as the performance achievements of the international joint research.

During the latter half of the 1990s, studies were conducted to identify the overall status of Korea's international joint research projects and suggest directions and strategies for the future international joint research. Cho and Ryu (1995) analyzed the current status of international joint research projects, identified the difficulties of promoting international joint projects, and presented directions for the international joint research. As a result, they claimed that we should focus on the establishment of an institutional basis by which the international joint research can be facilitated over the short term, and should also promote and spread the international joint research project led by Korea over the medium and long term. Yu et al. (1999) investigated into the current status of science and technology internationalization policies, among the international joint research projects, and derived strategic directions.

Entering the 2010's, research on the current status of the international joint research based on the network analysis, policy development, activation, and search of improvement measures flourished. Kim and Chung (2010) used the network analysis to empirically identify the current status of joint research among the Asian countries, where the number of joint researches conducted with Korea has greatly increased, by classifying them into the number of co-authored papers and subject categories. Through his research on the development of international joint research support policies centering on the network analysis between domestic research institutes in the basic and original fields, Kim (2015) proposed that the government's international joint research policies and programs must be developed. Yu and Kim (2016) utilized the network analysis to investigate and analyze the status and activities of international joint researches by each country, institution, and researchers in major new industries in Korea. Based on which, we searched for researchers and identified the current positioning of international joint researches in Korea by industry, and also identified the best institutions and researchers in Korea and the international joint research positions of researchers and institutions. Thereafter, studies were conducted to diagnose the current situation through comparison and analysis of activities of international joint research among the core researchers, focusing on the status of international joint researches between Korea and overseas major countries in the future, while studies on the development of fields and targets, and revitalization of international joint researches have also been conducted (Yoo, Kim, & Yang, 2017).

In addition, research on the result of the international joint research has included research on improvement of the performance product management, research on the performance quality, research on performance enhancement, and research on the performance security. Yoon (2009) analyzed the actual situation and problem of the performance management system related to the international joint research and presented the improvement plan, while Kim (2012) examined ways to improve the performance results of the international joint research targeting the research tasks at the initial and original source level in receipt of support for the national research and development projects. In addition, In addition, research on evaluating the quality of international joint research achievements (Kim et al., 2012) and research on policy recommendations (Kang & Kim, 2016) for effective performance security for conducting the international joint research centering on the improvement of laws and regulations related to international joint research have been conducted.

In addition to which, research on the status of international joint research in specific fields has been conducted by analyzing the status of the international joint research in the field of renewable energy and suggesting the strategic (Byun & Park, 2018), as well as the research on proposing facilitation policy directions by identifying characteristics of joint research in the field of BT (Jeon & Yi, 2018).

As a result of analyzing the previous researches related to the international joint research, many researches on the implementation strategy and the activation plan based on the international joint research status and the international joint research achievements have been conducted. Furthermore, various researches have been conducted on the ways of facilitating joint research in each field using the network analysis and research on joint research and joint research trends across specific fields. However, most of the studies have been conducted by analyzing the current situation of international joint research projects or by analyzing current status and the network based on international

joint research papers, and it was found that there were no studies which investigated on the actual situation and obstacles of the international joint research targeting the researchers who have actually conducted the international joint research or are engaged in such research.

Accordingly, this study intends to investigate the actual situation of the international joint research, investigate problems / difficulties, and based on which, suggest ways to facilitate the international joint research.

2.2 Current Status of the International Joint Research

According to the analytical data on the current status of the national research and development survey and report in 2017, most of the international joint and consigned research projects were conducted by the Ministry of Science, Technology and Information and the Ministry of Trade, Industry and Energy, and the major countries of collaboration were in the order of the United States, China, France, Germany, and the United Kingdom, respectively.

In 2017, the number decreased by 185 researches to 623 researches, among which the international joint researches declined by 31.0% (193 researches) to 429 year on year, and the international consigned researchers increased by 4.35 (8 researches) to 194 researches year on year. Examining by the ministry, the Ministry of Science, Technology and Information (285 cases, 45.7%) and the Ministry of Trade, Industry and Energy (154 cases, 24.7%) were found to be conducting most of the international joint and consigned researches. In particular, the Ministry of Industry, Ministry of Education and the Forest Service conducted international cooperation activities focusing on joint research, while the Ministry of Maritime Affairs and Fisheries, Meteorological Administration and the Ministry of Environment conducted international cooperation activities focusing on consigned research.

In terms of the international joint research, those conducted by the Ministry of Industry (205 cases, 57.1% change) decreased while the Ministry of Science, Technology and Information (12 cases, 7.5%) increased, and as for the international consigned researches, those conducted by the Ministry of Science, Technology and Information (4 cases, 3.4% change) declined and those conducted by the Ministry of Maritime Affairs and Fisheries (5 cases, 22.7%) increased.

Table 1. International joint and consigned researches conducted by key ministry

Year	Classification	International joint research		International consigned research		Total	
		No. of case	Weight	No. of case	Weight	No. of case	Weight
2015	Ministry of Science, ICT and Future Planning	**269**	52.0	113	60.1	382	54.2
	Ministry of Trade, Industry and Energy	162	31.3	-	-	162	23.0
	Ministry of Education	57	11.0	-	-	57	8.1
	Ministry of Maritime Affairs and Fisheries	-	-	27	14.4	27	3.8
	Defense Acquisition Program Administration	-	-	-	-	-	-

Year	Classification	International joint research		International consigned research		Total	
		No. of case	Weight	No. of case	Weight	No. of case	Weight
	Forest Service	14	2.7	-	-	14	2.0
	Meteorological Administration	-	-	6	3.2	6	0.9
	Ministry of Environment	-	-	9	4.8	9	1.3
	Other ministries	15	2.9	33	17.6	48	6.8
	Total	517	100.0	188	100.0	705	100.0
2016	Ministry of Science, ICT and Future Planning	161	25.9	116	62.4	277	34.3
	Ministry of Trade, Industry and Energy	**359**	57.7	-	-	359	44.4
	Ministry of Education	71	11.4	-	-	71	8.8
	Ministry of Maritime Affairs and Fisheries	-	-	22	11.8	22	2.7
	Defense Acquisition Program Administration	-	-	-	-	-	-
	Forest Service	14	2.3	-	-	14	1.7
	Meteorological Administration	-	-	4	2.2	4	0.5
	Ministry of Environment	-	-	9	4.8	98	1.1
	Other ministries	17	2.7	35	18.8	52	6.4
	Total	622	100.0	186	100.0	808	100.0
2017	Ministry of Science and ICT	**173**	40.3	112	57.7	285	45.7
	Ministry of Trade, Industry and Energy	154	35.9	-	-	154	24.7
	Ministry of Education	69	16.1	-	-	69	11.1
	Ministry of Maritime Affairs and Fisheries	-	-	27	13.9	27	4.3
	Defense Acquisition Program Administration	-	-	-	-	-	-
	Forest Service	7	1.6	2	1.0	9	1.4
	Meteorological Administration	-	-	2	1.0	2	0.3
	Ministry of Environment	-	-	10	5.2	10	1.6
	Other ministries	26	6.1	41	21.1	67	10.8
	Total	429	100.0	194	100.0	623	100.0

Examining the number of international joint research projects, 223 were the most performed in the United States, followed by 41 in China, 41 in France, and 36 in Germany, each respectively. As of 2017, the number of international joint and consigned researches has increased by 22 in the US year on year, while the numbers for Germany (30 cases), China (13 cases) and France (12 cases) have decreased. In particular, the United Arab Emirates conducted 23 international joint researches (3.7%) and was included among major international joint and consigned research conducting countries due to the increased information exchanges related to the nuclear power plants.

Examining the international joint researches conducted with major developed countries by type, international agreements executed with advanced economies such as the United States, France and Germany captured the largest share of international joint research, with 50.6% (217 cases) of international agreements, 26.6% (114 cases) of information exchange, and 22.8% (98 cases) of attracting foreign researchers, respectively.

Table 2. Trends in international joint and consigned research by major country, 2015-2017

Year	Classification	International joint research					International consigned research	Total	
		Foreign researcher attraction	Researchers' overseas dispatch	Information exchange	Technical training	International agreement		No. of case	Weight
2015	US	22	1	61	1	55	104	244	34.6
	Germany	4	-	9	-	40	6	59	8.4
	Japan	4	-	7	-	16	6	33	4.7
	France	1	-	2	-	45	2	50	7.1
	China	5	-	11	-	18	15	49	7.0
	UK	7	1	3	-	16	11	38	5.4
	UAE	-	-	32	-	-	-	32	4.5
	India	1	-	-	-	-	7	8	1.1
	Canada	4	-	2	-	8	5	19	2.7
	Russia	-	-	-	-	1	3	4	0.6
	Other nations	19	-	26	-	95	29	169	24.0
	Total	67	2	153	1	294	188	705	100.0
2016	US	17	-	44	1	47	92	201	24.9
	Germany	1	-	6	-	51	8	66	8.2
	Japan	2	-	6	-	13	4	25	3.1
	France	8	-	4	-	36	5	53	6.6
	China	4	-	19	-	15	16	54	6.7
	UK	3	-	7	-	23	6	39	4.8
	UAE	-	-	26	-	-	-	26	3.2
	India	3	-	-	-	-	7	10	1.2
	Canada	5	-	3	-	9	9	26	3.2
	Russia	-	-	-	-	1	5	6	0.7
	Other nations	38	-	46	-	183	34	302	37.4
	Total	81	-	161	1	378	186	808	100.0
2017	US	34	-	36	-	53	100	223	35.8
	Germany	2	-	1	-	25	8	36	5.8
	Japan	5	-	4	-	7	2	18	2.9
	France	-	-	5	-	33	3	41	6.6
	China	6	-	8	-	10	17	41	6.6
	UK	3	-	7	-	13	6	29	4.7
	UAE	-	-	22	-	-	1	23	3.7
	India	4	-	-	-	-	5	9	1.4
	Canada	8	-	2	-	5	12	27	4.3
	Russia	-	-	-	-	1	3	4	0.6
	Other nations	36	-	29	-	70	37	172	27.6
	Total	98	-	114	-	217	194	623	100.0

3. Methodology

3.1 Research Questions

As a result of analyzing the previous researches related to the international joint research, it has been found that multiple researches have been conducted based on the current status of the international joint research projects and international joint research papers such as those on the current status survey, trend analysis, facilitation and improvement measure, etc., for research and international joint research products. However, there have been no studies conducted for surveying into the actual condition of international joint research and problems / difficulties of the researchers who have actually conducted or are conducting the international joint research.

Accordingly, it is necessary to investigate the facts and obstacles of international joint research on researchers who have actually conducted or are conducting international joint research. Therefore, the following research questions may be raised.

- RQ 1: What is the purpose of conducting international joint research?
- RQ 2: What are the countries and research areas where international joint research is actively conducted?
- RQ 3: What are the factors which make international joint research products far more excellent than other researches?
- RQ 4: What are the difficulties / obstacles to conducting international joint research?

In order to address the above research questions, the related previous researches were surveyed and analyzed, survey was conducted on researchers who conducted or are conducting international joint researches, and intensive analysis and presentation of the discussed matters are intended.

3.2 Research Method & Research Procedures

In this study, the concept, scope, and type of international joint research are organized by surveying and analyzing existing previous studies by their entirety, and the researchers who have conducted or are currently conducting international joint research are surveyed in terms of the obstacles and difficulties in their conducting perception survey and international joint research. To this end, firstly, a comprehensive research and analysis of previous studies related to international joint research was conducted. Since the concept of international joint research is not clearly defined at the present, data were collected and analyzed by searching with similar keywords such as international joint research, joint research, international cooperative research, and international research and development. Second, questionnaires were developed through the previous studies and research process, and survey questionnaires were provided to the researchers who conducted or are conducting international joint research. Third, based on such, it is intended to identify the obstacles and problems in the international joint research through the perception survey of the international joint research and derive the improvement plan. The following are the details of the research procedures conducted step by step.

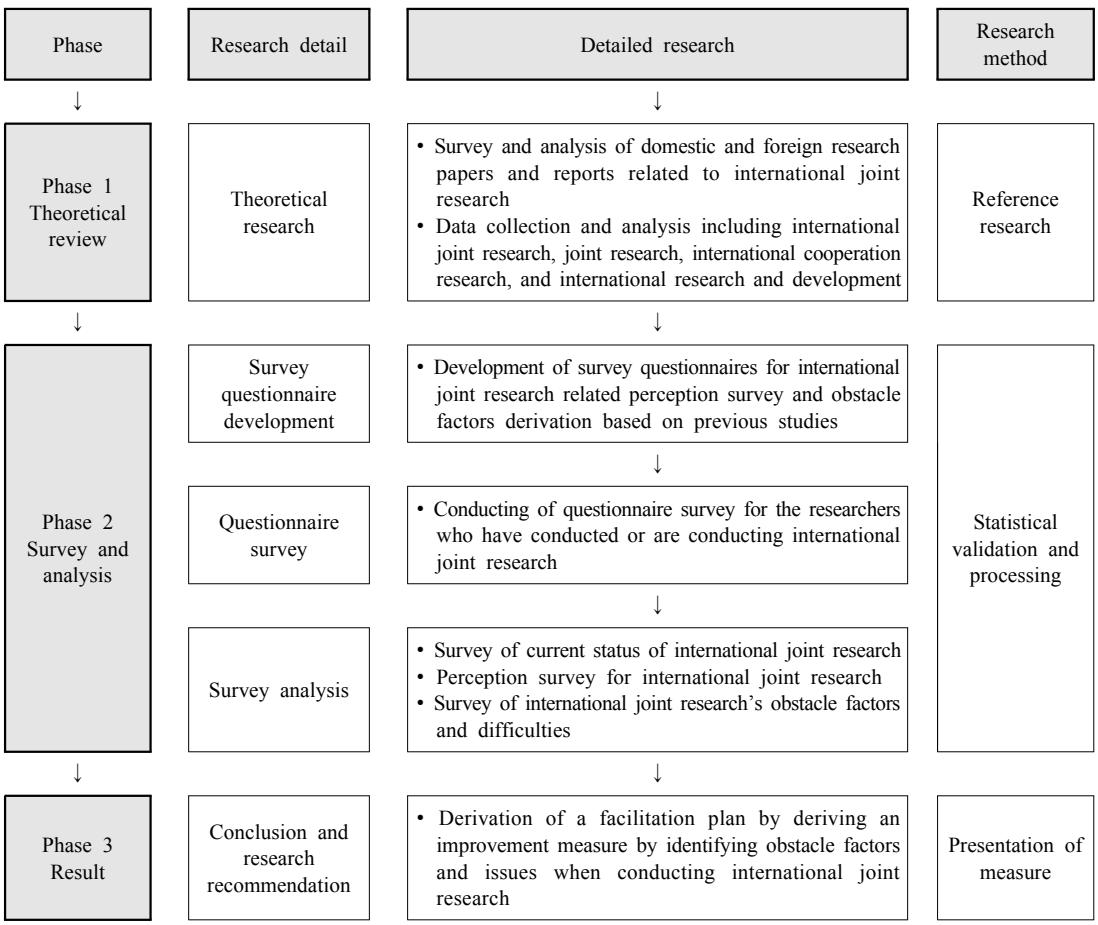

Fig. 1. Research procedures and research details

3.2.1 Selection of research subjects and the data collection procedures

In this study, surveys of researchers who have conducted international joint research with overseas researchers were conducted. Accordingly, the information was collected of the researchers who have conducted international joint research with NTIS, Korea Research Foundation, and KRI, etc.

The questionnaires were provided online, and for the first time, from October 8th through 24th, 2018, for approximately 2 weeks, the research directors of each project were called directly to ask for their response to the questionnaires. However, the response rate of the questionnaires was insufficient, and the questionnaires were redistributed by expanding the scope to the co-researchers for the second time. As a result, 113 copies were collected.

3.2.2 Contents of the questionnaires and the composition of questions

In this study, international joint research papers and various reports were surveyed and analyzed

to investigate the status, performance, merits, and difficulties of international joint research, thereby developing the questionnaires for the perception survey of international joint research targeting the researchers who have conducted or are conducting international joint research.

The questionnaires were largely divided into the 3 areas of general items for overseas researchers who conducted joint research with Korean researchers, purpose of international joint research, type, nature, category, form of collaboration, budget, among others including the status of international joint research, and performance result and difficulties of international joint research, and the details and the number of questions for each area are as follows.

Table 3. Details of questionnaire and the composition of questions

Item	Detail	No. of questions
General matters	Gender	9
	Age	
	Institution of affiliation	
	Major field	
	Final degree	
	Final degree awarding country	
	Country of affiliation for the overseas co-researcher	
	Institution of affiliation for the overseas co-researcher	
	Major field of the overseas co-researcher	
International joint research Current status	No. of international joint research	13
	Research period of international joint research	
	Research field of international joint research	
	Purpose of international joint research	
	Type of international joint research	
	Nature of international joint research	
	Category of international joint research	
	Form of international joint research	
	Selection of overseas researcher	
	Method of consulting with overseas researcher	
	Matters to share with overseas researcher	
	Form of cooperation with overseas researcher	
	Budgeting and management of international joint research	
Performance achievements and difficulties of international joint research	Satisfaction with international joint research results	6
	Key performance achievements of international joint research	
	Excellent performance achievement actors of other research reports of international joint research	
	Difficulties of international joint research	
	Matters to improve for conducting international joint research	
	Support policy required for international joint research	
Total		28

4. Results

4.1 General Matters

4.1.1 Demographic characteristics of the respondents

According to the demographic characteristics of the respondents, most were male respondents (92.92%), and in terms of age, those aged 50 or older were 68.14%, and those aged 40 through 49 were 27.43%, demonstrating that the researchers aged 40 or older were mostly involved in conducting international joint research.

As for the institutions of affiliation, colleges and universities were 95.58% and the government funded research institutes were 4.425%, demonstrating that most international joint researches are conducted by the researchers of colleges and universities. 39.82% of the respondents majored in engineering, 30.09% in natural sciences, 9.73% in medicine and pharmacology, etc., demonstrating the international joint research is actively conducted in the field of science and technology. In addition, final degrees were all doctoral degrees, and as for the final degree awarding countries, the US was accountable for 41.59%, Korea for 38.05%, and Europe for 10.62%, respectively.

Table 4. General matters of the respondents

Classification		N	%
Gender	Male	105	92.92
	Female	8	7.08
Age	Aged 29 or younger	0	0.00
	Aged 30-39	5	4.42
	Aged 40-49	31	27.43
	Aged 50 or older	77	68.14
Institution of affiliation	Government funded research institute	5	4.42
	University	108	95.58
Major field	Humanities	1	0.88
	Social sciences	8	7.08
	Natural sciences	34	30.09
	Engineering	45	**39.82**
	Medicine & pharmacology	11	9.73
	Agriculture & oceanography	9	7.96
	Arts & physical education	0	0.00
	Interdisciplinary studies	5	4.42
	Others	0	0.00
Final degree	Bachelor's	0	0.00
	Master's	0	0.00
	Doctor's	113	100.00
Final degree awarding country	Korea	43	38.05
	US	47	41.59
	Europe	12	10.62
	Japan	9	7.96
	Others	2	1.77
Total		113	100.00

4.1.2 Demographic characteristics of the overseas co-researchers

As a result of analyzing the demographic characteristics of the overseas co-researchers who conducted the joint research, the countries of affiliation of the overseas co-researchers were in the order of Asia and Oceania, Europe and the Americas, etc., respectively. In detail, the United States turned out to be the highest at 47.79%, followed by Europe and others for 34.51% (Sweden, Switzerland, Spain, the Netherlands, and Turkey, etc.), China for 25.5%, Japan for 22.12%, etc. As a result of analyzing the countries of overseas researchers by the major of the Korean respondent, engineering majors showed the most joint research with the US researchers, followed by 28.9% with those in Europe and 22.2% with those the UK. As for the natural sciences, 55.9% represented the US, 47.1% for Europe, 44.1% for Japan and 35.3% for those in China, etc., and as for medicine and pharmacology, 36.4% represented those in China and 27.3% for those in the US.

Examining the affiliated institutions of overseas co-researchers, it was found that 88.50% were universities, making it apparent that international joint researches were actively being conducted between universities, and besides, 28.32% represented national and public research institutes, and 17.70%, government funded research institutes, respectively.

As for the major of overseas researchers, 48.67% were engineering, 38.05% were natural sciences, and 11.50% were medicine and pharmacology, etc., respectively. As a result of analyzing the major of overseas researchers by the major of the respondents (Korean researchers), it was found that the international joint research is conducted with the researchers of almost the same major. As for the natural sciences, it was found that international joint research is conducted for natural sciences (88.2%) and engineering (17.6%), whereas for engineering, engineering (93.3%) and natural sciences (13.3%), whereas majors in medicine and pharmacology were found to be conducting international joint research with medicine and pharmacology (63.6%) and engineering (45.5%).

Table 5. General matters of the overseas researchers (multiple responses)

Classification			N	%
Country of affiliation of the overseas co-researcher	Americas (64)	US	54	**47.79**
		Canada	8	7.08
		South American countries	2	1.77
	Europe (91)	UK	16	14.16
		Germany	16	14.16
		France	17	15.04
		Russia	3	2.65
		Others	39	34.51
	Asia & Oceania (92)	Japan	25	22.12
		China	29	25.66
		India	7	6.19
		Australia	6	5.31
		Singapore	7	6.19
		Others	18	15.93

Classification			N	%
	Africa (9)	Republic of South Africa	2	1.77
		Others	7	6.19
Institution of affiliation of the overseas co-researcher	National and public research institute		32	28.32
	Government funded research institute		20	17.70
	University		100	**88.50**
	Large company		3	2.65
	Small to medium business		3	2.65
	Government ministries		5	4.42
Major field of the overseas co-researcher	Humanities		1	0.88
	Social sciences		9	7.96
	Natural sciences		43	38.05
	Engineering		55	**48.67**
	Medicine & pharmacology		13	11.50
	Agriculture & oceanography		10	8.85
	Arts & physical education		1	0.88
	Interdisciplinary studies		4	3.54
	Others		2	1.77

4.2 Current Status of the International Joint Research

4.2.1 Current status of the international joint research

As a result of analyzing the current status of the international joint research conducted thus far, approximately 70% were found to have conducted the international joint research 1 to 3 times, of which 25.66% were the highest with the researchers who conducted 3 times. In addition, 18.58% were the researchers who conducted the international joint research 8 times or more. As a result of analyzing the research areas by the number of international joint researches, it was found that international joint research is actively conducted in the field of engineering and natural sciences regardless of the number of times, of which natural sciences and engineering, in their order, were found to have been conducted international joint research for 8 times or more, respectively.

As a result of surveying the research period of the international joint research conducted, 6 to 12 months accounted for 33.36%, 13 to 24 months and 25 to 36 months each accounted for 28.32%, and 3 years and 1 month or longer accounted for 27.43%, etc., respectively. Accordingly, it was evident that the international joint research has been conducted in large number on an annual basis rather than short-term basis.

Table 6. Number of the international joint research and the research period

No. of international joint research			Research period of international joint research		
Classification	N	%	Classification	N	%
#1	25	22.12	Less than 6 months	9	7.96
#2	24	21.24	6-12 months	38	**33.63**
#3	29	25.66			
#4	6	5.31	13-24 months	32	28.32
#5	5	4.42			
#6	1	0.88	25-36 months	32	28.32
#7	2	1.77			
#8 or higher	21	18.58	3 years and 1 month or longer	31	27.43
Total	113	100.00			

4.2.2 Research area

As a result of surveying on the research areas of the international joint research conducted or being conducted, it was found that 43.36% were engineering, the field where international joint research is most actively conducted. In addition, 38.05% were conducted in natural sciences, 12.39% in medicine and pharmacology, and 11.50% in social sciences, demonstrating that most international joint researches are actively conducted in engineering.

Table 7. Research areas of the international joint research conducted / being conducted

Classification	N	%
Humanities	1	0.88
Social sciences	13	11.50
Natural sciences	43	38.05
Engineering	49	**43.36**
Medicine & pharmacology	14	12.39
Agriculture & oceanography	9	7.96
Arts & physical education	1	0.88
Interdisciplinary studies	4	3.54
Others	1	0.88

4.2.3 Purpose of conducting joint research with overseas researchers

As a result of surveying the purpose of conducting international joint research with overseas researchers, the formation of international research network turned out to be the highest at 67.26%, 50.44% for achieving performance at the global level, and 31.86% for securing or maintaining base for joint research overseas together with introducing advanced technologies, respectively. In addition, there were cases where joint research has been conducted to dispatch for training for graduate students / researchers, give presentation on research papers, and hold joint workshops,

etc. As for other opinions, technical support, science and technology ODA projects, supply and demand of manpower, and new product development, etc., were apparent.

Table 8. Purpose of conducting joint research with overseas researchers (multiple responses)

Classification	N	%
Introduction of advanced technology	36	31.86
Achievement of performance result at global level	57	50.44
Utilization of foreign research facility or equipment	22	19.47
Matching of research expenses of overseas researchers	10	8.85
Local commercialization such as overseas market entry	7	6.19
Training of graduate students / researchers	33	29.20
Securing or maintaining of joint research bas in foreign countries	36	31.86
Preliminary research for larger project development	19	16.81
Presentation of research paper at journals	27	23.89
Participation in large government policy projects	10	8.85
Acquisition of patents	1	0.88
Holding of joint workshops	24	21.24
Formation of an international research network	76	**67.26**
Invitation of experts	19	16.81
Others	7	6.19

4.2.4 Nature of the international joint research conducted

As a result of surveying the nature of the international joint research conducted, and when dividing largely in development study, applied study, fundamental study, purpose based research, and pure fundamental research, etc., the basic research turned out to be 59.29%, and it was shown that the international joint research is one which plays the role of expanding knowledge by clarifying theories for certain facts, and mainly is conducted with the purpose of developing theories or discovering principles or facts. In addition, 40.7% of the development researches were conducted, and besides, 28.31% of the applied research and 25.66% of the purpose-based research were found, respectively. Examining in detail, 42.48% of the researches which did not perceive of the industrialization / commercialization turned out to be the most, whereas the research and development research and those directly related to the purpose of industrialization / commercialization were each 20.35%, etc., respectively.

As a result of analyzing the nature of international joint research by the field of international joint research, as for the natural sciences, fundamental research or those which did not perceive industrialization / commercialization even as development study, and pure fundamental research, etc., were mainly conducted. As for engineering, development research and applied research, and those related directly to the purpose of industrialization / commercialization even as fundamental research were mainly conducted, so it was evident that there is a difference in the nature of international joint research depending on the field of research.

Table 9. Nature of the international joint research conducted (multiple responses)

Classification	N	%
Is development research and is not conscious of industrialization / commercialization	23	20.35
Is development research and related directly to the purpose of industrialization / commercialization	23	20.35
Is applied research and is not conscious of industrialization / commercialization	11	9.73
Is applied research and related directly to industrialization / commercialization	21	18.58
Is fundamental research and is not conscious of industrialization / commercialization	48	**42.48**
Is fundamental research and related directly to industrialization / commercialization	19	16.81
Is purpose based fundamental research and purely academic.	14	12.39
Is purpose based fundamental research directly related to industrialization / commercialization	15	13.27
Pure fundamental research	14	12.39
Others	2	1.77

4.2.5 Categories of the international joint research participated in

As a result of surveying the category of the international joint research participated in, it was found that 48.67% of the joint research with foreign scholars was the highest for developing research tasks as individual, followed by 23.89% participated in the joint research program selected as an agreement between governments, and 23.89% participated in the unit task of the large international joint research program implemented by Korea.

Table 10. Categories of the international joint research participated in (multiple responses)

Classification	N	%
Participation as a unit task of the international large-scale research program implemented by advanced economies	17	15.04
Participation as a unit task of the international large-scale research program implemented by Korea	27	23.89
Participation in a joint research program selected via intergovernmental agreement	53	46.90
Participation in a joint research program developed by my research organization	12	10.62
Develop a research project as an individual and conduct a joint research with foreign scholars	55	**48.67**
Others	3	2.65

4.2.6 Form of joint research when winning contracts for the joint research tasks

As a result of surveying on the form of joint research when winning contracts for joint research, it was found that over half autonomously decided research field and cooperating country and conducted

joint research. In addition, 38.05% were of the research form which was autonomous and designated for cooperating country, which seems to be caused by the fact that many cooperating countries have been designated for large research projects at the national level as well as for inter-governmental projects such as the Korea Research Foundation.

Table 11. Form of the international joint research participated in (multiple responses)

Classification	N	%
Autonomously decided on research field and cooperating country	58	**51.33**
Research field designated, cooperating country autonomously decided	19	16.81
Research field designated, cooperating country designated	20	17.70
Research field autonomously decided, cooperating country designated	43	38.05
Others	1	0.88

4.2.7 Selection of the overseas researcher selection route

As a result of surveying the selection route of overseas researchers, 59.29% accounted for the cases in which they conducted joint research by contacting the researchers in the course of conducting business as well as research, and 46.02% represented personal relationship, so it was apparent that for selecting overseas co-researchers mostly, they were contacted for research and business execution process, or through personal relationship. In addition. In addition, some researchers have been selected through contact with related researchers through research or by request of the other researcher, and other opinions included selection through the existing research cooperating researcher or academic societies.

Table 12. Overseas researcher selection route (multiple responses)

Classification	N	%
Personal relationship	52	46.02
Contact with researcher of related field via search of papers, etc.	20	17.70
Official route of institution	5	4.42
Request of the other researcher (research institute)	18	15.93
Contact with researcher in research and work performance process	67	**59.29**
Others	2	1.77

4.2.8 Consulting with the researchers of the other country

As a result of surveying the method of consultation with overseas researchers at the time of research, 75.22% of the respondents contacted by e-mail most frequently, 57.52% planned and discussed joint research by meeting scientists / professors of the other country at international academic conferences or seminars, and over half are also visiting in person to consult with the other country to development projects (55.75%).

Table 13. Consulting with the researchers of the other country (multiple responses)

Classification	N	%
Meet scientist / professor of the other country at international conference or seminar, plan and discuss joint research	65	57.52
Visit in person and negotiate at the other country for project development	63	55.75
Research director of the other country comes in person and consults for project development	35	30.97
Phone consultation	8	7.08
Messenger (Skype, etc.)	23	20.35
Communication via email	85	**75.22**
Others	2	1.77

4.2.9 Sharing with the overseas researchers

As a result of surveying on sharing with overseas researchers for joint research, it was found that 83.19% accounted for the research information, so it was apparent that research information was shared mostly during research. In addition, 49.56% were shared for researchers, 45.13% for materials / substances / samples / research materials, 43.36% for research equipment and facilities.

As a result of performing analysis by the field of joint research, research information was basically shared regardless of the research field, and in addition, the natural sciences shared material / substance / sample / research material and research equipment, and engineering shared research equipment and facilities, and research manpower, etc.

Table 14. Sharing with the overseas researchers (multiple responses)

Classification	N	%
Research expenses	34	30.09
Research information	94	**83.19**
Research equipment & facilities	49	43.36
Research manpower	56	49.56
Material / substance / sample / research material	51	45.13
Others	1	0.88

4.2.10 Forms of cooperation with overseas researchers

As a result of surveying the form of cooperating with overseas researchers when conducting the international joint research, it was found that research paper work accounting for 85.84% was the most common form of cooperation, and more than half of the researchers were engaged in the exchange of manpower such as attracting manpower and dispatch, and academic exchanges such as holding academic conferences.

Table 15. Form of cooperating with the overseas researchers (multiple responses)

Classification	N	%
Paperwork	97	**85.84**
Patent development	10	8.85
Manpower exchange such as attracting and dispatching manpower	62	54.87
Academic exchange such as academic conference	57	50.44
Commercialization of patents	3	2.65
Joint venture	0	0.00
Local demonstration for commercialization	8	7.08
Others	6	5.31

4.2.11 Budgeting and management

In the case of budgeting and management for conducting the international joint research, the budget of the Korean side was 73.45%, and the budget of the foreign country's research was 73.45%, demonstrating the form of being responsible for budge by each country. As for other opinions, a portion was borne by the Korean side, and in the case of foreign institution, they additionally input their own budget to create the budge, and support for the expenses of staying at the time of the overseas researcher's visit to Korea by need was apparent.

Table 16. Budgeting and management (multiple responses)

Classification	N	%
All the budget to be borne by the Korean side	31	27.43
Co-organize and use the budget to which the Korean and foreign sides contributed	23	20.35
Budget of the Korean side is the responsibility of the Korean institution, and that of the foreign side is the responsibility of the foreign institution	83	73.45
Others	3	2.65

4.3 Performance Achievement and Difficulties of the International Joint Research

4.3.1 Whether satisfied with the research performance result

As a result of surveying the satisfaction of the result of conducting the international joint research, "satisfied" turned out to be 84.07%, and "unsatisfied" turned out to be 0.88, respectively. It turned out that most researchers conducting international joint research were satisfied with the result of conducting international joint research.

Table 17. Whether satisfied with the result of conducting the international joint research

Classification	N	%	M	Std
Not satisfied at all	0	0.00	4.24	0.74
Not satisfied	1	0.88		
Average	17	15.04		
Satisfied	49	43.36		
Very satisfied	46	40.71		
Total	113	100.00		

4.3.2 Key performance achievements following the research

As a result of surveying key performance result after conducting the international joint research, research papers turned out to be the highest at 84.96%, followed by 62.83% for building a continuous research cooperation network, and 41.59% for nurturing manpower, etc., respectively.

Table 18. Key performance result after conducting research (multiple responses)

Classification	N	%
Papers	96	**84.96**
Patents	11	9.73
Commercialization (including technology transfer)	3	2.65
Startup	4	3.54
Development of a continuous research cooperation network	71	62.83
Nurturing of manpower	47	41.59
Others	2	1.77

4.3.3 Excellence of performance result of the international joint research

As a result of surveying whether they think performance result is better than other researches when conducting the international joint research, the improvement of the capacity of the Korea researchers turned out to be the highest at 4.04 in cooperation with the excellent overseas researchers, 4.03 for offering / publishing excellent papers in cooperation with excellent overseas researchers, and 3.28 for the excellence of the selected Korean researchers relative to other projects, respectively.

Through which, it was found that there is a difference between other researches in terms of competency improvement, excellent research paper submission and publication, and excellence of researchers, etc., when conducting international joint research, and that such factors enhance the satisfaction of international joint research.

Table 19. Whether they think the international joint research yields better performance result than other researches

Classification	Do not agree at all		Do not agree		Average		Agree		Agree very much		M	std
	N	%	N	%	N	%	N	%	N	%		
More research expenses than other projects	30	26.5	33	29.2	35	31.0	15	13.3	-	-	2.31	1.01
Enhancement of the Korean researchers' competency via cooperation with excellent overseas researchers	2	1.77	1	0.88	17	15.04	63	55.75	30	26.55	4.04	0.78
Submission / publication of excellent papers in cooperation of excellent overseas researchers	1	0.88	1	0.88	24	21.24	55	48.67	32	28.32	**4.03**	0.78
Excellent patent application / registration	9	7.96	23	20.35	59	52.21	19	16.81	3	2.65	2.86	0.89
To satisfy the evaluation criteria requiring excellent performance result	7	6.19	23	20.35	51	45.13	27	23.89	5	4.42	3.00	0.94
Excellence of the selected Korean researchers compared to other projects	6	5.31	9	7.96	52	46.02	39	34.51	7	6.19	3.28	0.90

4.3.4 Difficulties in conducting the international joint research

As a result of surveying the difficulties in conducting the international joint research, it was found that budget deficit turned out to be the highest at 3.88, and different administrative systems (form, project management method, etc.) at 3.58, insufficiency and lack of guidelines and roadmap for the international joint research at 3.12, respectively. As for other opinions, there were opinions about the burden of annual performance evaluation and others on the rigid administrative system for the multi-year tasks. Accordingly, it would be necessary to secure the budget, unify different administrative systems, develop guidelines and roadmap to facilitate the international joint research.

Table 20. Difficulties in conducting the international joint research

Classification	Do not agree at all		Do not agree		Average		Agree		Agree very much		M	std
	N	%	N	%	N	%	N	%	N	%		
Different administrative systems between countries (form, project management method, etc.)	2	1.77	9	7.96	42	37.17	42	37.17	18	15.93	3.58	0.91
Lack of experience in international joint research	9	7.96	28	24.78	46	40.71	26	23.01	4	3.54	2.89	0.97
Shortage or lack of guidelines and roadmap related to international joint research	7	6.19	20	17.70	46	40.71	33	29.20	7	6.19	3.12	0.98
Communication difficulties due to language and cultural differences	22	19.47	33	29.20	37	32.74	19	16.81	2	1.77	2.52	1.04
Budget shortage	-	-	3	2.65	33	29.20	51	45.13	26	23.01	**3.88**	0.79

4.3.5 Matters of improvement for the international joint research project

As a result of surveying the matters of improvement for the international joint research project, research fund support issue (lack of research funds, etc.) turned out to be the highest at 4.01, issue of research period at 3.73, research performance index problem at 3.46, and the issue of research task selection at 3.42, etc., respectively. It was apparent that the problem of lack of research funds, which turned out to be high in both difficulties and matters of improvement, was the largest difficulty in conducting the international joint research, and measures for expanding support will be needed.

Table 21. Matters of improvement for the international joint research

Classification	Do not agree at all		Do not agree		Average		Agree		Agree very much		M	std
	N	%	N	%	N	%	N	%	N	%		
Issue of the research project selection	4	3.54	4	3.54	55	48.67	41	36.28	9	7.96	3.42	0.83
Issue of the research management system	4	3.54	14	12.39	48	42.48	37	32.74	10	8.85	3.31	0.93
Issue of the research performance result index	3	2.65	12	10.62	42	37.17	42	37.17	14	12.39	3.46	0.94
Issue of research period	1	0.88	5	4.42	35	30.97	54	47.79	18	15.93	3.73	0.81
Issue of research expenses support (lack of research funds, etc.)	-	-	1	0.88	25	22.12	59	52.21	28	24.78	**4.01**	0.71
Difficulty of practical international cooperation	7	6.19	18	15.93	54	47.79	30	26.55	4	3.54	3.05	0.90

4.3.6 Supporting policy for conducting joint research with the overseas researchers

As a result of surveying the support policies needed for the international joint research, the support for the formation of a continuous cooperation network turned out to be 4.33, project operation according to the mid- and long-term plan and strategy of the government at 3.88, introduction of project implementation system reflecting characteristics of the international joint research at 3.79, and the strengthening of administrative support for the overall international joint research at 3.60, etc., respectively.

Table 22. Support policy required for conducting the joint research

Classification	Do not agree at all		Do not agree		Average		Agree		Agree very much		M	std
	N	%	N	%	N	%	N	%	N	%		
Project operation following the government's mid- and long-term plans and strategies	2	1.77	5	4.42	26	23.01	52	46.02	28	24.78	3.88	0.90
Introduction of project implementation system reflecting characteristics of international joint research including role sharing with overseas researchers	2	1.77	4	3.54	30	26.55	57	50.44	20	17.70	3.79	0.84
Strengthening of the expansion and utilization system of ownership and license rights for joint research results	5	4.42	9	7.96	54	47.79	40	35.40	5	4.42	3.27	0.85
Strengthening of administrative support for the overall joint research of the institution of affiliation	3	2.65	8	7.08	37	32.74	48	42.48	17	15.04	3.60	0.92
Support of the overseas cooperation base center when cooperating with the cooperating country	5	4.42	19	16.81	40	35.40	39	34.51	10	8.85	3.27	0.99
Introduction of performance management system via various performance achievements by focusing on papers and patents	5	4.42	15	13.27	43	38.05	42	37.17	8	7.08	3.29	0.94
Support for the formation of a continuous cooperation network	1	0.88	7	6.19	60	53.10	44	38.94	1	0.88	4.33	0.65
Provision of relevant information on overseas cooperating country and field of cooperation	4	3.54	5	4.42	47	41.59	44	38.94	13	11.50	3.50	0.89

5. Discussion

The goal of this study is to investigate the actual situation of international joint research and investigate the problems / difficulties of international joint researchers who have conducted or are conducting the international joint research, based on which to propose ways to facilitate the international joint research. Based on the findings of the study, some discussions are as follows.

5.1 Ensuring the Autonomy of Research Topics

Most international joint research projects currently being conducted are of the top-down format, often with a research theme or country determined in advance. There is a limit to the support

for the researcher as the subject matter is designated in advance. Accordingly, in the future, the international joint research projects should be autonomous in terms of top-down method and their designation as well as the country designation. In addition, since there is an imbalance between the Korean and international research trends, such as the unexplored areas in Korea and the areas that have not yet attracted great attention, they are actively studied abroad, and so there is a need for providing support to ensure that Korean studies do not fall behind international standards as a matter of minimum requirement.

5.2 Absence of Contractual Infrastructures Such as the Absence of Guidelines for the International Joint Research

Article 4 Paragraph 4 of the "Regulations on Management of National Research and Development Projects" provides that the head of a central administrative agency, when implementing national research and development projects, must encourage international networking and cooperation such as exchange of manpower and international academic activities with foreign countries as well as international joint research with a view to enhance the efficiency of the research and development. However, detailed procedures and regulations for planning, evaluation and management of international joint research are not in place for the lack of a legislative system, and there is no guideline which may be used for any ministry. Such a problem is important in that, when compared to the system in which a partner of our joint research resides, and whose support system operates such as that legal support system offers legal and standardized contract, among other guidelines, when implementing an international joint research with such a party, Korean research institute may have an inferior negotiating power. Moving forward, it will be necessary to develop guidelines and legal infrastructures for the unity of international joint research.

5.3 Simplification and Unification of the Administrative Work System

Among the difficulties of the international co-researchers, it was found that there are difficulties in the different administrative systems (form, project management method, etc.) between the countries, and common complaints about unnecessary administrative tasks were also found in other opinions. In particular, there were too many unnecessary forms and paper works related to the processing of overseas researchers, and there were too many documents to submit. For example, despite the fact that mutual visiting research is a key issue for establishing a network, unnecessary documents are required for overseas visits, and there are cases where an invitation letter is required from a foreign researcher even though it is an academic exchange task. In addition, since the relevant documents to be delivered to overseas institutions are not translated into English at the time of conducting the international joint research, it is difficult for the researchers to translate them individually or to submit the documents themselves in the form of HWP files, further to the need for preparing the materials in both English and Korean, among other difficulties.

Accordingly, moving forward, in the case of international joint research project, it is necessary to propose the administrative system guidelines with the uniformity of the countries in advance,

and also consider the introduction of the system for planning and evaluating in English only from the start.

5.4 Inadequate Regulations Related to the International Joint Research's Performance Results

International joint research ought to be approached from the national strategy level by considering the systematic acceptance of overseas advanced technology and the prevention of unauthorized leakage of Korean core technology. However, the present lack of law makes it very difficult to effectively implement such national research and development performance management policies. In particular, in the case of the national research and development projects in which public funds are injected, considering the proposition that the acquisition and use of the project results should be beneficial to the national interest, there is a problem in allowing parties to each agreement to decide arbitrarily as in the present. There also seems to be difficulties in executing the actual agreements. In addition, as the globalization of science and technology progresses, international joint research will increase further (Yoon, 2009). In order to effectively respond to this, it is important to establish a national performance management system and a performance management system for research institute which conducts the actual research projects. This is because the execution and management of the research and development agreements, which are the premise of the achievement management, depend on the capacity and the operating system of the unit institution. However, as we have seen, Korean public research institutes have not developed or managed their own regulations or operating systems.

That is, in the past, international joint research itself was not facilitated, and the joint research field was conducted mainly across fundamental sciences such as high energy and physics, failing to attract much interest nor yield much research product such as patent. However, as the international research environment has greatly expanded, the scope of international joint research has expanded to advanced application fields such as IT, BT and NT, and the types of joint research are further diversified into joint research agreements, corporate research institutes, invitation of scientists, etc. It is also anticipated that there will be conflicts of interest among the joint research participants in the ownership of the research performance achievements, and the occurrence of important achievements such as intellectual property rights which could have a large impact on national technological innovation and industrial development. Accordingly, it is necessary to operate a systematic legal system at the national level for the management of international joint research results, and it is necessary to establish a reasonable system.

6. Conclusion and Recommendation

The goal of this study is to investigate and analyze the current status of the international joint research conducted by the researchers who have actually conducted or are engaged in the international joint research, based on which to identify difficulties involved in implementing the international joint research and propose the ways of facilitating the international joint research in the future.

As a result, first, as for the current status of international joint research, engineering was found

to be 43.36%, which was found to be the field in which international joint research is most actively conducted, international joint researches are conducted for the formation of international research network and achievement at global level. As for the nature of international joint research, over half were found to be the fundamental researches, and the selection of research field and cooperating country was conducted autonomously ensuring that joint researches are conducted at most. The selection of overseas researchers was conducted based on contact or personal friendship in the course of research and work, and most of the consultations were conducted by email, and they visited international conferences or in person to other countries for consultation. It was also found that research information is the most commonly shared when conducting the international joint research, and the form of main cooperation is research paperwork.

Second, the results of international joint research show that many researchers are satisfied with the results of international joint research. As a result of the research, it has been shown that the research result is the network of a continuous research cooperation with papers, and in cooperation with overseas researchers who are excellent in performance excellence, the selected Korean researchers have enhanced their competency and demonstrated their excellence relative to other projects such as by excellent research paper submission and publications in cooperation with excellent overseas researchers.

Third, the budget deficit turned out to be the largest difficulty for conducting international joint research, and there was insufficient administrative system (form, project management method, etc.), and the lack of guidelines and roadmap for international joint research was apparent. In addition, as for the improvement of the international joint research project, there apparently were research fund support problems (such as the lack of research funds), issue of research period, research performance index problems, and the selection of research projects.

Lastly, for the support policies required for conducting joint research, it was found that support for the formation of a continuous cooperation network, support of the government through the mid-and long-term plans and strategies, introduction of a project implementation system reflective of the characteristics of international joint research, and support for strengthening administrative support for the overall international joint research by the institution of affiliation are needed.

Moving forward, it will be necessary to ensure the autonomy of research subjects in order to facilitate international joint research, build infrastructures for the international joint research guidelines and contracts, simplify and unify the administrative work system, and supplement regulations on performance achievement.

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