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Analysis of Perception Difference in R&D Planning and Evaluation Following Characteristics of Convergence Researcher: Focused on Humanities, Social Sciences, and Science and Technology Majors and Areas

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ABSTRACT

This study focuses on the differences of the researchers' perception in the process of convergence research. In particular, it is assumed that the gap between the researchers in the implementation and evaluation stages has a significant influence on the stage of finding a theme for convergence research. Specific details are as follows. First, we examine the heterogeneity between disciplines through the conceptual definition of concepts and types of convergence research by reviewing previous studies related to convergence research. Second, we analyze differences in the researchers' perceptions about obstacles that occur in the convergence research process. Third, the factors for promoting convergence research will be derived through this process, and future convergence research directions will be presented. Fourth, we intend to emphasize the importance of cooperation and interest among researchers by presenting appropriate directions for the planning, performance and evaluation of convergence research.

1. Introduction

The wave of globalization has brought about changes in social, economic and cultural order and has also transformed into a monolithic system that eliminates physical barriers between countries and is linked closely to each other. Various social problems arising from this situation face uncertainty because they contain diversity and heterogeneity, and one social problem is rapidly connected with other social problems, overlapping and further resulting in complex social problems. That is, the social problems that arise in the individual countries in the wave of globalization are spreading

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not only to differentiated or specific areas or situations but also to the problems facing the world as a whole.

With the development of science and technology, a lot of information has emerged and the knowledge based on it has been produced and reproduced. Problems that arise at the individual and group level have formed a common concern that is spread across the globe and confronted across national boundaries. Global warming and energy problems, and financial crisis are most representative in this regard, and in order to solve these problems, intellectuals are making a concerted effort.

The research trend of the existing academic field was to calculate theory and technology through scientific research at a single academic level. However, prescriptive research is being attempted to solve such a social problem according to various changes of society. Furthermore, as diversity, complexity, and uncertainty increase in as much as it is called the age of uncertainty, these convergence studies are becoming increasingly more active. Researchers have been concerned with how to set up research topics and conduct research in order to solve complex social problems arising in the era of uncertainty. In addition, discussions are underway of what kind of results will be generated through these research processes.

As for the struggles of these researchers, they grew the perception of difficulties in accessing them through research themes and methodologies in a single discipline, which have led to the preception that heterogeneous disciplines have created the same goal and achievement through research collaboration. This may be said to be the beginning of interdisciplinary research and the early form of interdisciplinary phenomenon.

As interdisciplinary researches continue, the so-called 'convergence field' has emerged, and the activation of convergence research has facilitated the development of human-friendly innovation technologies as well as solving complex problems in society.

However, the convergence phenomenon between academic fields through interdisciplinary research is occurring in reality, but the concept of convergence research and the type of methodology are not established. Although the forms of early convergence are heterogeneous disciplines, they have been forms of convergence between disciplines in science and technology and disciplines within the humanities and social science. Currently, however, forms of convergence between disciplines such as humanities and social science convergence based on science and technology, and science and technology convergence based on humanities and social science are taking place. This makes conceptualization of convergence even more difficult.

For the diversity of concepts and types of convergence research, the basis of financial support to facilitate convergence research may not be clear. This means that it is difficult to set standards for the planning, implementation and evaluation of research projects for financial support and management. Therefore, it is necessary to define the concept and type of convergence research and to diagnose various problems occurring across the convergence research process.

It may be inferred that the reason for the diversification of these concepts and the difficulty in setting the criteria in the research process is due to the difference of perception of convergence research in each academic field, and there is a limit that can not be linked to the creation of the original research result due to the difference of perception. Originally, interdisciplinary convergence research has started for the same research purpose between heterogeneous disciplines, so diversity

and heterogeneity exist in the nature of the original discipline and the academic values of the researchers. In addition, it is difficult to integrate these diversity and heterogeneity through the convergence research process.

This study focuses on the differences of the researchers' perception in the process of convergence research. That is, convergence research has started as a research method for the efficient solution of research problems, but it has been pointed out that the original purpose of research execution is insufficient due to large and small conflicts in actual implementation process. In particular, it is assumed that the gap between the researchers in the implementation and evaluation stages has a significant influence on the stage of finding a theme for convergence research. Specific details are as follows.

First, we examine the heterogeneity between disciplines through the conceptual definition of concepts and types of convergence research by reviewing previous studies related to convergence research.

Second, we analyze differences in the researchers' perceptions about obstacles that occur in the convergence research process.

Third, the factors for promoting convergence research will be derived through this process, and future convergence research directions will be presented.

Fourth, we intend to emphasize the importance of cooperation and interest among researchers by presenting appropriate directions for the planning, performance and evaluation of convergence research.

2. Theoretical discussion of convergence research

2.1 Type and concept of convergence research

The convergence research field that has been actively researched recently is becoming increasingly global (Lee, 2013). Research related to convergence R&D been attempted for the first time in the field of science and technology, and it is steadily increasing mainly in the convergence of science and technology. In recent years, there has been a movement to reinterpret the approach of convergence research according to the proportion of participation of humanities and social science and science and technology in the convergence of research of social problem solving type (Song, 2015; Kim et al., 2014).

Convergence research has been facilitated by the need for interdisciplinary research in the development of social situations and technologies, rather than through scholarly discussions at the beginning. Therefore, this means that it is necessary to grasp the process of convergence research in order to define the concept of convergence research.

There are cases where changes in knowledge production methods are pointed out to the cause of convergence research. Gibblons et al. (1994) classified the knowledge production method into two types. The first type is the knowledge production that occurs in a single discipline, and the second type is the type of knowledge that arises from interdisciplinary research collaboration. Nowotny et al. (2001) specifically classified two types of characteristics. The first type of characteristic is

that knowledge production that occurs in a single discipline has a unique subject, and that originality within the discipline is important. Whereas, the second type has the social utility value in mind, emphasizing quality rather than quantitative research results. The second type is the study of inter-disciplinary convergence, and the importance of this type is based on the practicality of the study. As research activities are facilitated, researchers participating in research activities are engaged in diverse fields such as government, business, and civil society in their own academic production areas such as universities, so that practicality and realism are emphasized and that the conditions for achieving these goals are secured (Song, 2012: 137-138).

In classifying the convergence research type, the most commonly used are the 'Multidisciplinary', 'Interdisciplinary', and 'Transdisciplinary' categories defined by the OECD.[1)] (Han & Kyung, 2011: 152) First, multidisciplinary convergence research refers to convergence research through research collaboration between fields that maintain a boundary between disciplines and are likely to be converged in each discipline (Schumer, 2004; Mallon & Burton, 2005; Hukkinen et al., 2006: 2-3). This type of convergence research is centered on research topics, and the linkages between disciplines are relatively weak. Second, the interdisciplinary convergence research is a form in which interdisciplinary interactions between diverse disciplines are emerging (Bruun et al., 2005; 29 Schummer, 2004; Mallon & Burton, 2005). In this form, boundaries between disciplines may appear unclear and research collaboration can be very active. Third, the form of research on the integration of super-disciplinary convergence research is a form in which researchers in each discipline identify realistic problems together and diagnose and prescribe social problems through convergence research between disciplines (Frodeman, 2010). In this case, the forms of physical combination between disciplines disappear, and two disciplines can appear in the convergence discipline.

The concept of convergence research can be defined based on the cause and type of convergence research. The dictionary meaning of convergence is "merged," which means not just a physical integration, but a chemical combination (Joo & Lee, 2012: 526). First, the concept of convergence derived from the cause of convergence research can be defined as a combination of disciplines based on practicality in order to solve social problems. Second, the concept that can be derived from the type of convergence research is that the researchers of each independent discipline need not be physically combined through a temporary research cooperation but to have the same problem awareness or research purpose, Therefore, if we define convergence research, it can be defined as a study through chemical combination between disciplines with the same problem consciousness and purpose in order to solve social problems.

2.2 Need for convergence research

As we have reviewed in the conceptual definition of convergence research, when the convergence research is defined as the research cooperation by interdisciplinary chemical interactions for solving social problems, the primary need of convergence research can be understood as solving social

1) In 1970, the OECD held international conferences to distinguish the 3 terms of multidisciplinary, interdisciplinary, and supercritical to define the concept of convergence in the process of activating convergence research between disciplines (Apostel et al., 1972: 25-26).

problems. This is a classification centered on the cause of convergence research. Besides, the need of convergence research can be grasped from the result of convergence research. That can be summarized as follows.

First, the need for convergence research is raised for the purpose of solving social problems. A convergent approach is needed to solve social problems that arise as society becomes more complex and uncertain. Social problems are the traditional problems that arise with the creation of mankind, but the ripple effects of social problems appear different from generation to generation. For example, social problems in the past have been caused by problems of simple social institutions and structures, and their effects have also influenced within a limited scope. In contrast, current social problems have been influenced by various factors such as institution and structure, behavior of social members, and these problems can be combined and amplified into larger social problems or closely linked with each other, making it even more difficult to solve. Moreover, the increase in uncertainty makes future predictability less likely to make social problem solving more difficult. There is a limit to the single academic level approach to solving social problems, and the possibility of solving social problems can be increased through information exchange and joint research among disciplines.

Second, research productivity can be enhanced through convergence research as an advantage. The productivity is defined as the ratio of quantitative and qualitative performance, which is calculated relative to input factors such as labor force, budget, etc. to be carried out for the conduct of research (Kim & Kim, 2011: 4-5; Hwang, 2008: 105-106). Although input factors of research productivity include quantitative indicators such as manpower and budget, there are also qualitative indicators such as researcher's effort, creativity, and research environment. Even with the same quantitative input, there is a difference in research productivity if there is a qualitative difference in quality. Recent research has also been conducted to demonstrate that research productivity is enhanced through convergence research (Lee & Choi, 2010; Hong, 2014; Hwang, 2015; Choi & Song, 2015). This can occur when the convergence research is conducted rather than the quantitative input factor. The creativity of the research topic, the research environment, and the researcher's efforts are reduced through the research of the researchers among the research fields. At the same time, it is possible to inject high quality elements. Such a productivity can arise in various fields such as researchers, project undertaken by researchers, research performing organizations, and the national level in research (Lee, 1996: 29).

Third, convergence research can act as a factor to establish academic community by activating expert network. Moody (2004) argues that scientific and technological knowledge must be approached from a social perspective and that a network of experts be established between these disparate disciplines. This points towards the importance of networks in convergence research. That is, it can be seen that the process of conducting convergence research itself is a process of establishing a network between disciplines (Cho & Kim, 2005: 121). Convergence research can also be activated depending on the degree of connectivity of such a network.

2.3 Two approaches to convergence research

This research suggests that convergence research can achieve synergistic effects because it breaks down the boundaries between disciplines and approaches with a common new research topic and purpose. Nevertheless, there are various obstacles to realization of convergence research. This is due to differences in perception among academic disciplines in conducting convergence research.

Peer review, which evaluates the research value of other researchers, is a common evaluation of the results produced through convergence research. In this peer assessment process, convergence researchers may find it difficult to appreciate the true value of their performance (Lee et al., 2015). This suggests that although the research paradigm is changing due to the need for convergence research, they tend to maintain specific themes and methodologies in the existing single discipline within the discipline (Rhoten, 2004).

Specifically, convergence research can produce qualitative research achievements and raise the issue of research outcomes even though the achievements are highly academic. This is because the convergence research is not established in one discipline and is performed according to the research topic and research situation, and also because of the rejection of convergence research data, lack of appropriate journal to place convergence research, and issues of placement of appropriate reviewers and qualitative issues of examination (Campbell, 2005).

The limitations of convergence studies arising from differences in perception among such disciplines are not significant in the same discipline or similar disciplines, but they can occur frequently in heterogeneous disciplines. In particular, it can be seen in the recently discussed approach of humanities and social science based science and technology or science and technology based humanities and social science. The conceptual definition of the two approaches still differs between scholars.

First, in the case of science and technology based humanities and social science convergence, it means that synergy effects can be created through research cooperation in fields where science technology and humanities and social science fields are closely interconnected (Park, 2014: 544). This approach predicates that science and technology exist to promote human values. Therefore, the results produced by carrying out studies related to science and technology should seek human convenience (Choi, 2009). That is, in the process of convergence based on science and technology, the convergence of knowledge leads to the convergence of technology, and the convergence of products is based on the convergence of technology, and in this process, it is suggested that humanities and social science should be included (Kim et al., 2014: 453).

Second, although the ultimate aim of the convergence of science and technology based on the humanities and social science is premised on promoting the value of human beings, it emphasizes the characteristics of the humanities and social science and focuses on the human centered science and technology design (Choi & Ban, 2015: 8). That is, such an approach emphasizes harmony between disciplines within a single large category of human value enhancement, rather than seeing the humanities and social science as two separate disciplines. If we understand the differences of these views, if the result of convergence of humanities and social science based on science and technology is in products with convergent tendencies, it can be said that the convergence of science

and technology based on humanities and social science represents the identity of research to pursue human convenience. This means that if the former is to innovate the product (market) by utilizing the humanities and social science elements of science and technology, then the latter can be interpreted as developing original technology reflecting the humanities and social science demands and factors, and seeking to pursue such directions.

The commonalities of the two approaches are that humans are the ultimate subject of convergence research, and they conduct human centric research. The differences are where the center lies among the areas of science and technology and humanities and social science. It can also be distinguished in terms of the process of conducting convergence research and results. In the case of science and technology based convergence research, the final research result is intended for humans. Research on the humanities and social science based convergence emphasizes the importance of humanities and social science at the time of research planning and emphasizes the linkage with science and technology. In addition, the approach between the two disciplines is not clearly established conceptually, and the two approaches are differently named depending on whether the academic field of the researcher is the humanities and social science or science and technology.

3. Survey design

3.1 Differences in perception model in the convergence research process

Realistically, there is a gap in scholarship between the humanities and social science and science and technology. This difference in perception is not the difference between the two approaches, but rather occurs in the process of conducting a convergence research between researchers in the humanities and social science and researchers in science and technology.

The process of convergence research is the same as the process of general research but includes the convergence process between the disciplines. First, when a researcher creates a new research idea, a research collaboration with a researcher who has a similar topic or the same research purpose in other disciplines begins. This is the beginning of convergence research. Second, convergence researchers submit research proposals to research support organizations or receive research support from institutions to utilize research results in order to establish the overall plan of research and to secure financial support for conducting research. Third, when financial support such as research funding is made, convergence researchers conduct research, seeking the unity of research contents and method among academic fields and making efforts for creating new results through convergence research. Fourth, peer review is conducted by evaluating the research achievements that are obtained through the convergence research, at which time the quantitative and qualitative levels of the research results are identified.

3.2 Define variables and set measurement scale

Differences in perceptions between researchers in the humanities and social science and science

and technology can be seen throughout the course of this research. First, in the planning stage, research topics and methodologies are selected for conducting convergence research. The basic research infrastructure for conducting convergence research is also important. Unlike general research, the convergence research is based on joint research among disciplines, so it is important to support basic research infrastructure such as the scope of human resources or budget. In this case, there may be a discrepancy in perception of convergence research depending on whether there is a specific research topic or methodology before convergence between disciplines, or existence of existing research infrastructure. Second, the role of convergence researchers or the allocation of research resources plays an important role because the research is carried out in earnest during the research stage. In the absence of a clear role or assignment of research support among the disciplines in the research stage, research leadership may be important, which may lead to problems in the conduct of research. There may also be a difference in the perception of which academic field is leading the research director who oversees the research.

Third, performance and quantitative and qualitative level calculated by convergence research can be important variables in research evaluation stage. There is a difference in perceptions about the outcome of research between research fields, because research results expected by research fields may be different.

Table 1. Defining variables and setting measurement variables

Research stage	Variable	Variable's definition
Planning stage	Need for convergence research specialized R&D	• Recognizing the need for R&D research support for convergence research
	Perception difference in planning convergence research	• Perception of design such as theme, subject of cooperation and methodology, etc., in the planning stage of the convergence research • Differences in awareness in planning stages of researchers in the humanities and social sciences and technology
	Convergence centric field of study	• Type and scope of academic field that should be emphasized in humanities and social science / science and technology
Implementation stage	Problems in the research implementation stage	• Recognition of differences in roles, research resource allocation, and leadership among humanities and social science / science and technology researchers in the course of research
	Selection method for convergence researcher	• Recognition of the selection method of the research director in the convergence research process
	Humanities and social science researchers' participation method	• Recognition of appropriate participation methods when participating in research on humanities and social sciences
Evaluation stage	Need for evaluation index (quantitative / peer evaluation)	• Types and scope of evaluation of convergence research results
	Priority in the evaluation of convergence research	• Priority recognition based on the type of achievement in evaluating convergence research results

In this study, measurement variables were set according to the definitions of these variables. First, the variables in the planning stage suggested the need for R&D specialized in convergence research, the difference of perception in the stage of convergence research planning, and the field of convergence research. Measuring scales include the search and identification of collaborative objects for convergence, the derivation and discovery of topics through convergence, the design of specific methodologies for conducting convergence research, the constraints of research collaboration methods, and the emphasis on humanities and social science and science and technology .

Second, the variables at the stage of research implementation suggested the problem in the research stage, the method of selecting convergence researchers, and the way of participating researchers in the humanities and social science. As for the measurement index, the problems in the research stage were the inefficiency of resource allocation, the difference of performance perception, the role formation among research participants, and the leadership of the research leader. The measurement index for convergence researchers' appointing a research director for a social studies major, appointing a research director with a science and technology major, and appointing a joint research director for a humanities social science and science technology major. In addition, as a method of participating experts in the field of convergence research by the academic field, the specialists of the humanities established a separate preplanning project, the students of the humanities major participated in the research group, and the experts of the humanities field set the participation as research advisors.

Third, in the research evaluation stage, the need of evaluation index (quantitative / peer evaluation) and priority in convergence research evaluation were suggested. As for the measurement indexes, the need of measurement evaluation and need of peer evaluation other than the quantitative evaluation were suggested for the need of evaluation indexes. The priorities in the evaluation of convergence research are presented as scale of papers, patents, technology transfer, customer satisfaction, institutional sales profit, and peer evaluation, etc. As mentioned above in the preceding research, considering that the convergence research is not settled in one discipline and that it is important to conduct the convergence research in a process, we attempted to identify characteristics of each researcher's field of study by classifying each evaluation stage.

3.3 Survey method and sample design

The purpose of this study is to analyze the difference of perception among researchers in the humanities and social sciences and science and technology. For the research analysis, we conducted a questionnaire survey on researchers in humanities and social science and researchers in science and technology. The survey was conducted from June 10 to July 10, 2015 with 110,000 researchers registered with the National Research Foundation of Korea. We conducted an online questionnaire survey using the National Research Foundation of Korea's survey system. Of the total respondents, 276 were selected, and only the researchers in the humanities and social science, and science and technology removed the remaining samples (arts and physical education and others). The total sample of respondents was 259.

Expert respondents were 48.3% (125 persons) in the field of science and technology, and 51.7%

(134 persons) in the humanities and social science. The proportion of researchers in the humanities and social science was relatively high, and a similar percentage of specimens were obtained. Second, most of the respondents were researchers with more than 10 years of research experience, with 43.6% (113) of them having more than 20 years of experience, and 35.1% (91) of them with 10-20 years, and so it may be said that the validity of the questionnaire for research analysis is secured.[2)]

Table 2. General characteristics of sample

Classification		Frequency	%
Major area	Science and technology	125	48.3
	Humanities and social science	134	51.7
	Total	259	100.0
Research experience	5 years or less	20	7.7
	5-10 years	35	13.5
	10-20 years	91	35.1
	20 years or longer	113	43.6
	Total	259	100.0

The questionnaire constructed a measurement scale based on the variables extracted from the stage of the convergence research, and allowed the researcher to respond to the question using two types of closed and open ended questions. The questionnaire constructed for this study consisted of open ended questions together with closed ended questions. In the case of open ended questions, it is possible to give flexibility to questions about the variables and to understand the perceptions of respondents. (Park, Oh, & Song, 2015: 531). In addition, open-ended questions in terms of the results of the research have the advantage that they can discover new facts that the researcher who conducts the survey does not recognize. Since convergence research is conducted in various disciplines, it is difficult to grasp convergence research situations such as research environment, process, and research results in the process of actual convergence research. In addition, new variables such as obstacles that occur in the convergence research process can be identified. In this regard, it is meaningful to investigate through the open ended questions.

2) Reviewing research experience by field in this study, 57.3% (55 people) of experts had a long experience of 20 years or more in the field of science and technology, 39.7% (50 people) of experts had 10 to 20 years of experience in the field of humanities and social science, and 34.9% (44 people) had 20 years or more, and so the research experience of researchers in science and technology field turned out to be relatively higher. The results of this survey are not related to the development of the paper but are treated as footnotes as reference materials.

Table 3. Measurement scale and questionnaire configuration method

Variable	Measurement scale	Questionaire configuration
Need for convergence research specialized R&D	• Level of need for convergence research	• Closed ended
Perception difference in planning convergence research	• Exploring and finding cooperation targets for convergence • Derivation and discovery of theme through convergence • Designing specific methodologies for conducting convergence research • Constraints on research collaboration	• Closed ended • Open ended
Convergence centric field of study	• Humanities and social science / science and technology centric discipline	• Closed ended (Multiple responses)
Problems in the research implementation stage	• Inefficiency of resource allocation, difference in perception of performance, establishment of role among research participants, leadership of research leader	• Closed ended • Open ended
Selection method for convergence researcher	• Selection of research director of humanities and social / social science major • Selection of research director of science and technology major • Selection of joint research director of humanities and social science / science and technology major	• Closed ended • Open ended
Humanities and social science researchers' participation method	• Humanities major conducts separate pre-planning research • Humanities major participates in research group • Experts in the field of humanities participate as research advisors	• Closed ended • Open ended
Need for evaluation index (quantitative / peer evaluation)	• Need for quantitative evaluation and peer evaluation other than quantitative evaluation	• Closed ended • Open ended
Priority in the evaluation of convergence research	• Papers, patents, technology transfer, consumer satisfaction level, institutional sales profits, peer evaluation	• Closed ended • Open ended

4. Analysis of convergence researcher's difference in perception for R&D process

4.1 Analysis of perception difference in humanities / science / technology fields in planning stage

4.1.1 Difference in perception for the need of specialized R&D in convergence research

We analyzed the differences in perception of the need for specialized R&D in convergence research. Most researchers have recognized the need and scope of convergence research (88.8% of the total). This suggests that the direction of government R&D policy is suggested for the activation of convergence

research, and it should be also interested in the classification system of R&D field. The difference between the researchers in the humanities and social science and science and technology is statistically significant and the researchers in the science and technology field have a relatively high level of awareness. However, in recognizing the need for specialized R&D for convergence research, it may be said that the significance through the differences in perception may be small.

Table 4. Recognition of the need for R&D specialized in convergence research

Field	Absolutely necessary	Necessary	Average	Unnecessary	Absolutely unnecessary	Total
Science and technology	85 (68.0)	25 (20.0)	12 (9.6)	2 (1.6)	1 (0.8)	125 (100.0)
Humanities and social science	71 (53.0)	49 (36.6)	12 (9.0)	2 (1.5)	0 (0.0)	134 (100.0)
Total	156 (60.2)	74 (28.6)	24 (9.3)	4 (1.5)	1 (0.4)	259 (100.0)

$\chi^2 = 9.739^{**}$ $df = 4$ * $p<0.05$

4.1.2 Perception difference in the stage of convergence research planning

The perception of the factors necessary for conducting the convergence research in the planning phase of the convergence research is analyzed as follows. 32.8% of respondents (85 people) answered that they need to derive and find out the subject through convergence, and 30.9% (80 people) of respondents answered that they need to search and find cooperative objects for convergence. This suggests that it is important to select the researchers in the field of convergence research and those in the field of convergence as well as to elicit and discover the theme of convergence research at the planning stage of convergence research.

In the humanities and social science and science and technology fields, 34.4% of the total in the field of science and technology were considered to be the most important factor in planning stage through the convergence. In the case of humanities and social science, it was perceived that searching and finding subjects of cooperation for convergence are important.

This is so because, in the case of science and technology, convergence research is relatively long compared to the field of humanities and sociology, and so, in science and technology based convergence research approach, it is possible to suggest the need for infrastructure support for researchers in the humanities and social science to conduct convergence research.

In addition, researchers in both science and technology and humanities and social science are at a disadvantage in the perception of convergence research at the planning stage, and since the research base itself is inferior to the new research field, if the purpose of the initial convergence research is clear, it also emphasizes the need for institutional support for budget and manpower operations.

Table 5. Need for convergence research by humanities and social science / technology engineer in planning stage

	Exploring and finding collaborative subjects for convergence	Deriving and discovering theme through convergence	Designing methodology for conducting convergence research	Need for cooperative manner (physical distance, etc.)	Other	Total
Science and technology	34 (27.2)	43 (34.4)	28 (22.4)	11 (8.8)	9 (7.2)	125 (100.0)
Humanities and social science	46 (34.3)	42 (31.3)	26 (19.4)	9 (6.7)	11 (8.2)	134 (100.0)
Total	80 (30.9)	85 (32.8)	54 (20.8)	20 (7.7)	20 (7.7)	259 (100.0)

χ^2 =2.341 df =4 * p<0.05

Through the open ended questionnaire, we analyzed the necessary factors at the planning stage of the convergence research and analyzed the difference of perception among the disciplines. They perceived of the opportunity to conduct convergence research in common and the need for advance communication between disciplines.

Table 6. Necessary factors for convergence research in the convergence research planning stage (Open ended question)

Classification	Common	Science and technology	Humanities and social science
Necessary factors in the planning stage of convergence research	• Opportunity to conduct convergence research granted • Advance communication between disciplines • Evaluators suitable for the convergence research evaluation exist	• Lack of interdisciplinary experience in the field of humanities and social science • Improvement of selective support system for each field	• Prevailing convergence research centered on science and engineering • Lack of awareness of researchers in the field of humanities and social science for convergence research

4.1.3 Perception difference in convergence research centric fields

Convergence research occurs across all disciplines. At the present time, we have conducted a survey on the field in which convergence between academic disciplines was activated in conducting convergence research. This question was designed to identify the areas of research where convergence research is active or likely to be activated, and multiple responses were obtained to identify the researchers' various perceptions.

First, in terms of convergent disciplines in the field of science and technology, the results of the analysis show that for the disciplines that are likely to be activated, the convergence research in the field of information communication (19.6% of the total) and the field of health care (13.5%) were highly perceived. There was no significant difference in awareness of the possibility of con-

vergence discipline recognized by researchers in the humanities and social science and science and technology fields.

Second, the fields that are likely to converge in the field of humanities and social science are social / human / welfare / women (12.8% of total), cognitive emotional science (10.5% of total), culture / arts / sports (9.4% of total), respectively. In the case of humanities and social science, social / welfare / women (12.7% of total) and education (10.3% of total) showed differences in the perceptions of researchers between the humanities and social science and science and technology fields (12.9% of the total), and cognitive emotional science (14.2% of the total). Researchers in the humanities and social science were aware of the possibility of convergence in education. From these results, the researchers were highly aware of the possibility of convergence in the social or social welfare field. In the field of science and technology policy, there is a representative study of the convergence of social problem solving which is being studied continuously.

The above results show that the convergence research between the humanities and social science and the science and technology fields in the field of information communication, healthcare, and social welfare is activated, and the possibility of convergence research in these fields may be said to be high.

Table 7. Perception of convergence focused fields by R&D area

Fields available for convergence with science and technology fields				Fields available for convergence with humanities and social science fields			
Name of field	Science and technology	Humanities and social science	Total	Name of field	Science and technology	Humanities and social science	Total
Math	9(3.2)	10(4.0)	19(3.6)	History/Archaeology	15(4.9)	11(3.7)	26(4.3)
Physics	9(3.2)	3(1.2)	12(2.3)	Philosophy / religion	11(3.6)	16(5.3)	27(4.4)
Chemistry	8(2.9)	2(.8)	10(1.9)	Language	3(1.0)	16(5.3)	19(3.1)
Earth science	6(2.2)	5(2.0)	11(2.1)	Literature	3(1.0)	12(4.0)	15(2.5)
Life science	22(7.9)	19(7.7)	41(7.8)	Culture / arts / sports	34(11.0)	23(7.7)	57(9.4)
Agriculture, forestry and fisheries food	11(4.0)	11(4.5)	22(4.2)	Law	2(.6)	12(4.0)	14(2.3)
Healthcare	33(11.9)	38(15.4)	71(13.5)	Politics & government	13(4.2)	19(6.3)	32(5.3)
Machinery	26(9.4)	9(3.6)	35(6.7)	Economics & business management	20(6.5)	21(7.0)	41(6.7)
Materials	14(5.0)	3(1.2)	17(3.2)	Society / humanity / welfare / women	40(12.9)	38(12.7)	78(12.8)
Chemical engineering	6(2.2)	2(.8)	8(1.5)	Life	21(6.8)	5(1.7)	26(4.3)
Electric / electronic	29(10.4)	27(10.9)	56(10.7)	Geography / region / sightseeing	18(5.8)	26(8.7)	44(7.2)
Information communication	47(16.9)	56(22.7)	103(19.6)	Psychology	27(8.7)	17(5.7)	44(7.2)
Energy resource	12(4.3)	15(6.1)	27(5.1)	Education	20(6.5)	31(10.3)	51(8.4)
Nuclear power	4(1.4)	2(.8)	6(1.1)	Media / communication	26(8.4)	23(7.7)	49(8.0)
Environmental	18(6.5)	28(11.3)	46(8.8)	Brain science	12(3.9)	10(3.3)	22(3.6)
Construction / transportation	24(8.6)	17(6.9)	41(7.8)	Cognitive emotional science	44(14.2)	20(6.7)	64(10.5)
Total	278(100.0)	247(100.0)	525(100.0)	Total	309(100.0)	300(100.0)	609(100.0)

4.2 Analysis of perception difference by humanities / science and technology for research stage

The difference of perception between the humanities and social science in the research stage is largely determined by two factors:

4.2.1 Prerequisites for conducting convergence research

We analyzed the perception of the prerequisites in the process of convergence research by presenting the problems that occurred during the implementation stage of convergence research. Overall, 47.5% of the respondents recognized the difference in academic and technical performance perceptions, and 24.7% of the respondents said that the roles of participating researchers were unclear. There was a statistically significant difference between the humanities and social science and science and technology fields, but the interpretation was not significant because there was a difference at the perception level.

In the course of conducting a full fledged convergence research, it is traditionally the difference in approach to phenomena that the researchers make a difference in the perception of the performance that is calculated through the convergence research. That is, in the case of science and technology, the academic tendency is results oriented in the production of the product or the discovery of the physical phenomenon, whereas in the humanities and social science, the focus is on the value or relationship. The implication of this result is that when the convergence research between the humanities and social science and the scientific and technological fields is carried out, researchers will need to perceive in advance and approach characteristics between disciplines. This is important when considering that the ultimate goal of convergence research is the overall integration goal and the interdepartmental chemical combination. In addition, when establishing the future convergence research policy, the government or the research institute for the convergence research should recognize the difference of the perception and establish the policy and the plan for the supported convergence research project.

Table 8. Perception of problems in the implementation stage of convergence research

	Inefficiency of resource allocation	Differences in performance perceptions (academic achievement vs. technical achievement)	Unclear role definition among research participants	Lack of leadership	Other	Total
Science and technology	12 (9.6)	55 (44.0)	35 (28.0)	12 (9.6)	11 (8.8)	125 (100.0)
Humanities and social science	17 (12.7)	68 (50.7)	29 (21.6)	10 (7.5)	10 (7.5)	134 (100.0)
Total	29 (11.2)	123 (47.5)	64 (24.7)	22 (8.5)	21 (8.1)	259 (100.0)

$\chi^2 = 12.719^{**}$ $df = 3$ * $p<0.05$

4.2.2 Perception difference following the type and scope of human resources participating in convergence research

(1) Selection method for research director

The research director is a key participating subject in R&D. The research director supervises the overall research plan including research theme, research subjects, and research methods, predicts the research results through continuous monitoring during the research process, and acts as a control tower in the communication of research participants. These activities are directly linked to the creation of research results. There are also empirical studies (Pinto & Covin, 1989: 32) that research outcomes can vary according to the type of leadership of the research director. In addition, the effect of technology development and technology transfer is high, depending on the intensity and will of the research director (Thursby & Thursby, 2002). Therefore, depending on which research director is selected in the convergence research, it is possible to secure the continuity of convergence between academic fields in addition to the quantitative and qualitative levels of the convergence research results.

Researchers in heterogeneous disciplines, such as the humanities and social science, play a role in coordinating the conflicts that arise between the two academic communities, as well as research achievements. In the process of conducting the research, the researcher responded that 52.5% of the researchers needed to appoint a joint research director between the humanities and social science and science and technology as a whole, due to the difference in perception of the method of appointing the research director in the implementation stage of the convergence research. There was a difference in perception that there was a difference in perception between the two disciplines, and it was statistically significant.

This result is a very interesting result and has important implications. Overall, it is said that the appointment of a joint research director is necessary, but in this case, the issue of how to resolve conflicts that arise during the course of research is raised. Therefore, it can be judged that there is a claim that one's own field should lead research. It is also possible to predict that the convergence research direction will change depending on whether the research director is selected or not, when the convergence research shows that there is a difference in the approaches to the convergence research between the humanities and social science fields. In addition, in the domestic research environment where research fund management is being conducted by selecting a research fund management agency, conflicts concerning the appointment of research leaders are likely to continue to arise.

Table 9. Selection method for the convergence research director

Field	Selection of research director of humanities and social science / social studies major	Selection of research director of science and engineering major	Selection of joint research director of humanities / social science - science / technology major	Other	Total
Science and technology	5 (4.0)	39 (31.2)	60 (48.0)	21 (16.8)	125 (100.0)
Humanities and social science	36 (26.9)	7 (5.2)	76 (56.7)	15 (11.2)	134 (100.0)
Total	41 (15.8)	46 (17.8)	136 (52.5)	36 (13.9)	259 (100.0)

χ^2 =48.328*** df =3 * p<0.05

Specifically, open ended questions can be used to identify the method of appointing a convergence research director, which can be classified into five categories of research ideas and subjects, research capabilities, research ratios, roles, and correctness. That is, the researcher should be selected through consultation based on the research theme, or a researcher with abundant experience in convergence research. It was also suggested that a research director should be appointed according to the percentage of participation in the research project. In addition, because convergence research has the characteristics of application and development research, it is necessary to judge the important factors of marketability and to provide the majors who have science technology and business management to create new business or new market.

Table 10. Perception of selection of the convergence research director (Open ended)

Classification	Type Classification	Response Details
Selection of convergence research director	Research ideas and themes	• Selection through consultation according to research theme • Researchers who can draw a total picture of research
	Research capacity	• Selection of a researcher understanding the concept of convergence and experienced in convergence research • Researcher capable of performing research theme best
	Research ratio	• Selection of research director according to participation rate of research project
	Role	• It is important how research director shares research team structure and role.
	Marketability	• Majors in science and technology and management to create new businesses / new markets

(2) Method of participation for humanities and social science researcher

The emergence of convergence research has begun with increasing social demand and expectations for research outcomes. This is because it has been difficult to meet these social needs with the achievements of one discipline in the existing disciplined discipline. The convergence movement began in the field of applied research rather than basic research, and the field of science and technology played a leading role. Therefore, interdisciplinary research or convergence research between the humanities and social science and science and technology fields is a common research based on science and technology. This is due to the lack of conceptual definition of convergence research based on humanities and social science. In this study, we have investigated and analyzed the participation method of humanities and social science researchers in convergence research considering the situation of interdisciplinary convergence research.

Overall, 57.5% of the respondents thought that humanities majors should participate as researchers in convergence research. The difference in perception between researchers in the humanities and social science and science and technology fields is that more than half of the researchers in science and technology recognize that humanities majors should participate as researchers (64.8% of the total), and researchers in the humanities and social science (50.7% of the total) humanities majors should participate in research group, and also responded that the study of the humanities majors should be carried out separately (36.6%). This result shows a statistically significant difference.

While there is a difference in the academic approach between the humanities and social science and the science and technology, there was a high opinion that the researchers in the humanities and social science should be involved in the convergence research. This suggests that both academic communities are expecting creative research performance through convergence research despite academic heterogeneity. In addition, the researchers in the humanities and social science have a relatively high perception that they should carry out the preplanned research. It is also important to directly participate in the research, but it is also important to establish the philosophy of the humanities and social science in the preplanning stage. This result can be used as a criterion for determining the role of researchers in the field of humanities and social science at the time of establishing policies or plans for future research.

Table 11. Expert participation method in humanities and technology convergence R&D project

Field	Humanities major conducted a separate pre-planning study	Humanities major participated in research group	Humanities expert participated as research advisor	Other	Total
Science and technology	20(16.0)	81(64.8)	17(13.6)	7(5.6)	125(100.0)
Humanities and social science	49(36.6)	68(50.7)	11(8.2)	6(4.5)	134(100.0)
Total	69(26.6)	149(57.5)	28(10.8)	13(5.0)	259(100.0)

$\chi^2 = 14.390^{***}$ $df = 3$ * p<0.05; ** p<0.01; *** p<0.001

4.3 Analysis of perception difference in humanities and science / technology in the evaluation stage for convergence research

Evaluation is an important tool in judging the outcome of research. The evaluation of the need for evaluation is divided into conceptual and instrumental aspects in terms of usability (Shin, 2008). Conceptual use is intended to change the perceptions of stakeholders associated with evaluation or evaluation results, and instrumental use is to provide a basis for establishing research support policies in the future. That is, the evaluation is the basis of planning for the support of the post research study, and it is an opportunity to encourage the researchers who carry out the research project and strengthen the research capacity.

The question of how to evaluate the research results calculated through the research can be raised. This is important because it is the time, purpose, and method of evaluation of the research outcome, and the academic and social value of the research outcome depends on the evaluation. In the same context, there is a question of how to evaluate the results of convergence research. In this study, we identified the evaluation criteria for the convergence research and analyzed the perception of the criteria for the quantitative evaluation and the convergence research evaluation, and also the difference of the perception standard between the humanities and social science and the science and technology fields.

First, in the evaluation stage of convergence research, the perception that a quantitative evaluation

index is needed as a whole was relatively high (56.4% of the total). There was no statistically significant difference between the humanities and social science and science and technology fields. On the other hand, the perception that the quantitative evaluation was difficult was somewhat higher (43.6% of total). This suggests that it is not easy to quantitatively evaluate convergence research, but it suggests that it is important to develop a specific evaluation index that fully reflects the characteristics of convergence research.

Table 12. R&D evaluation of major area central to R&D's quantitative evaluation

Field	Need for R&D central to quantitative evaluation index	Quantitative evaluation is unfeasible	Total
Science and technology	72(57.6)	53(42.4)	125(100.0)
Humanities and social science	74(55.2)	60(44.8)	134(100.0)
Total	146(56.4)	113(43.6)	259(100.0)

$\chi^2 = 1.587$ $df = 1$ * p<0.05; ** p<0.01; *** p<0.001

Second, the analysis of the researchers' perceptions about the method of evaluating the convergence research results showed that paper (36.3% of the total) and consumer satisfaction (36.3% of the total) were relatively high, respectively. The differences of perception between the humanities and social science and science and technology fields were statistically significant. In the science and technology field, 47.2% of the respondents showed high satisfaction (44.8% of the total), whereas in the case of science and technology, the research result of convergence tendency was preferred, while the field of humanities and social science is more important to recognize academic meaning and achievement in the convergence research process. Hence, a balance between quantitative and qualitative performance is needed. Instead of overcoming the mutual perception difference right now, it is necessary to plan a way to offset the mutual perception difference through an advanced R&D project design.

Table 13. Priorities in R&D project evaluation

Field	Paper	Patent	Technology transfer	Consumer satisfaction level	Contribution to growing company's revenue in sales	Peer evaluation	Total
Science and technology	34 (27.2)	4 (3.2)	7 (5.6)	59 (47.2)	3 (2.4)	18 (14.4)	125 (100.0)
Humanities and social science	60 (44.8)	5 (3.7)	10 (7.5)	35 (26.1)	12 (9.0)	12 (9.0)	134 (100.0)
Total	94 (36.3)	9 (3.5)	17 (6.6)	94 (36.3)	15 (5.8)	30 (11.6)	259 (100.0)

$\chi^2 = 20.271$*** $df = 5$ * p<0.05; ** p<0.01; *** p<0.001

4.4 Summary and implications of analytical results

We analyzed researchers' perceptions of convergence research at each stage, focusing on the process of convergence research, and analyzed the difference of perception by dividing academic discipline into humanities and social science and science and technology.

First, understanding the perception of convergence research in the planning stage, most researchers recognized the need of convergence research on the need of the field specialized in convergence research in research support. In addition, it suggested the need of deriving and extracting the subject through convergence as a whole in the planning stage of convergence research. Open ended questions suggest that convergence research opportunities should be ensured for the necessary factors at the planning stage of convergence research, communications should be established in advance between disciplines, and appropriate evaluators for convergence research must exist in advance. In the field of humanities and social science, the convergence research centered on science and technology has been proposed, and the need for convergence research centered on humanities and social science has been suggested. However, researchers in the field of science and technology have suggested that researchers in humanities and social science are lacking interdisciplinary experience, demonstrating a difference in perception.

Second, they recognized that there is a gap between academic and academic performance perceptions as a whole on the prerequisites for conducting convergence research in the implementation stage of convergence research. This means that researchers need to recognize and approve the specificities of scholarship in advance when researches are conducted between academic disciplines, which can solve the problem of interdisciplinary conflict that arises in the convergence process. There is also a very interesting result in the way the research director is appointed. Overall, there was a strong perception that researchers should be selected jointly across disciplines, but there was a strong perception that research director in each field should be appointed. This result should be carefully considered because the researcher plays a very important role not only in the subject of the research but also in the direction of the research. In addition, in accordance with the principle of centralized management of research funding, researchers should be cautious because they are in charge of the research, such as the utilization of research funds. However, through open ended questions, research ideas, research capacity, proportion of participation in research, role in research performance, and marketability are suggested for the selection of the director of convergence research. This is a meaningful analysis result. In addition, the results of the perception analysis of the participation method of the convergence research in the humanities and social science researchers were also meaningful. In both disciplines, they thought positively about people majoring in the humanities and social science participating as researchers. In particular, researchers of humanities and social science have recognized that they should carry out preplanned research in convergence research, and will be possible to present the scope of the researchers' role.

Third, in the evaluation of convergence research achievement, both quantitative and qualitative evaluation should be performed. In the method of evaluation, researchers in the humanities and social science preferred papers, and those in the science and technology preferred consumer satisfaction. These results are also very important for their implications. In the field of science and technology,

there is an increase in applied research due to its focus on production activities. However, there is a difference in perception of achievement among scholars because the philosophy and value based research have been continued in the field of humanities and social science. This is consistent with the tendency that researchers in the humanities and social science place more emphasis on the process rather than the achievement of the research. Before the full fledged research is carried out, it can be understood that the philosophical idea of convergence research in the humanities and social science is important. In addition, despite the difficulty of quantitative evaluation of convergence research, the ratio of recognizing that the development of specialized quantitative indicators within a range that does not hinder the characteristics of convergence research is relatively high implies that the evaluation index of the government convergence R&D is not reflective of such characteristics, and also demonstrates that the convergence R&D measurement and evaluation index should be developed in the future.

5. Conclusion

This study analyzed the difference of perception between the humanities and social science and science and technology fields in R&D planning and implementation tasks and evaluation stages according to characteristics of convergence researchers. The results of this study suggest that there may be conflicts between scholarly activities in the convergence research process due to the difference of perception among the scholars in the convergence research, but these obstacles can provide the criteria to overcome obstacles.

First, researchers in the humanities and social science and science and technology fields can seek cooperation in a positive direction to foster convergence research. Most notable is the perception of the need for research and development that is specialized in convergence research. Despite the differences in academic perception based on convergence research, they are respecting the scholarly value of each field and increasing the possibility of convergence in the selection or research director or participation of research group.

Second, it is important to select the topic of convergence research because it emphasizes the importance of advance communication that can resolve the conflicts between disciplines for conducting convergence research. However, it is important to know whether or not to build the network. To this end, it is necessary to establish an academic network in the field of convergence, and the research support institutions such as the government should establish a basis for activating the academic network.

Third, the roles of government and research support institutions will be important in the process of creating the environment in which researchers in the humanities and social science and science and technology fields conduct convergence research. However, problems of artificial support can exist. In the process of identifying convergence projects and supporting research, in artificially setting the percentage of people who participate in convergence research, the proportion of participation among the disciplines, or the budget, the purpose of research support may be to encourage interdisciplinary research or convergence research, yet the possibility of autogenous convergence of an artificially

constructed research community can be lowered. Since convergence research is based on the difference between the academic disciplines, it may be a difficult problem and many research institutions will need to struggle about it.

Fourth, continued endeavors will be needed to derive the evaluation index of convergence research. The reason as to why the convergence research result is not derived in proportion to the change of social demand is because of the difficulty in carrying out the convergence research further to the lack of recognition for the qualitative value of the achievement. Hence, a highly sophisticated evaluation index and system should be constructed for the activation of convergence research.

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