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Bibliometrics for Advancement R&D Planning
: Detecting Emerging Trends in Scientific Literatures

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〈목 차〉

Ⅰ. Introduction

Due to the 'Winner Takes All' global competition principle, the struggle for R&D is intensifying throughout the main countries of the world. Consequently, increased support for R&D and other various policy formulating activities have been deployed in Korea. For instance, in 2004 the Science and Technology Minister was raised to the deputy prime minister to resolve problems regarding preliminary policy coordinating, as in the 'absence of formulating forces', and post-factum policy coordinating for evaluation. These efforts of the government were introduced to the OECD as examples to reduce uncertainty around science and technology, being recognized as signals of the upcoming 3rd generation reformation policies in Korea(EC, 2005).

In spite of these efforts planning and policy coordinating on the national scale has not been

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promoted effectively(Yeom, 2006), arousing criticism of being plans of "excessive in quantity and insolvent in quality" in National R&D project levels(Jang & Jeong, 2004).

To overcome the R&D productivity cultures and R&D inefficiencies indicated as limitations of Korea's national reformation projects, the significance of planning is being upraised as one of the numerous alternative measures. Although the number of National R&D tasks has exponentially increased from 21,237 in 2001 to 33,125 in 2007, number of projects have jumped from 217 in 2001 to 426 in 2007, and investments have surged from 4500 billion won in 2001 to 9500 billion won in 2007(Ministry of Education, Science and Technology, 2008), research planning activities have barely been modified and neither did the manpower input and budget.

On the contrary, uncertainty to the R&D environment such as acceleration of technology fusion compounding has greatly increased, and the complexity of research planning has greatly risen with the growth in size of National R&D projects. Recently, a basis of national-scaled visions and mid-long term policy plans have been applied to link up project planning and task planning together, with a top-down methodology being underscored to solve tasks, leading to a greater significance in the planning stages.

With the premise that the inefficiency of National R&D has partially arisen from problems in the planning stages, the government has demanded intensified planning processes as a solution to inefficiency matters in main reports by the National Science and Technology Council.

As a new technique in recent research projects, the Information Analysis Method is gathering ground. For efficient planning of National R&D projects supplementation by a Information Analysis Method for the existing Peer Review Method is necessary.

Information analysis is "collecting information through quantitative analysis of papers and patented data which represent outcomes of science technology, as well as producing new knowledge by computer modeling". This analysis is originated in the 1950s when understanding of quantitative analysis was insufficient, through Eugene Garfield when he created the Science Citation Index which deals with data, developing into a conceptual tool for analyzing science technology, and through this, the basis of currently known areas of information analysis in Bibliometrics, Informetrics, Cybermetrics, Webmetrics was formed. These methods are being utilized in diverse areas through DB expansion, development of modeling techniques by the computer, and increased capability of statistical analysis.

The objectives of this paper can be explained in mainly two aspects. First, the limitations of the peer review which is currently used mostly in R&D planning and its methodology. Second, the recently headlined information analysis methods and a system developed by KIAT(Korea Institute for Advancement of Technology), RADERSTM(Research Area DEtection through R&d information Scanning), are introduced with emerging examples of the 10 technology (semiconductor, display, digital broadcasting, mobile communication, BcN, next generation computing, SW solutions, digital contents, embedded SW, data information security) selected by Ministry of Knowledge Economy in Korea.

Ⅱ. Limitation of R&D planning and Paradigm Shift of R&D Planning

2.1 Limitation of R&D planning

Planning refers to the futuristic, persistent and active process of making decisions by inquiring alternative plans to accomplish a certain goal, and selecting the most optimal plan[Choi et al., 2005], while the ultimate goal of planning is to reduce uncertainty(Dvir & Lechler, 2004).

Just as the stratum structure of planning is divided into policy planning, strategy planning, operation planning for better understanding of the range that planning covers(Choi et al., 2005), R&D planning can also be divided into policy planning, project planning and task planning(Lee, 2006). In this view, R&D planning can be defined as "a serial process of setting goals and establishing specific methods and processes to achieve those goals targeted for R&D, a special field that possesses a stratum structure of policy-project-task".

Park et al.(2007) pointed out that the current problems of R&D planning in Korea are intuition centered R&D planning by experts, the existing tendency of expert centered planning, disorganized and fragmental planning, linear and disposable planning. In this study, the problems of intuition centered R&D planning by experts, that is, the problems of peer review are mainly depicted.

Peer review is unquestionably the core process of qualitative evaluation. However, there can be several serious disadvantages of peer review and related expert-based evaluation methods(Moxham & Anderson, 1992; Horrobin, 1990). Among these, the main problems relates to subjectivity, that is, decisions and results by individual peer members are being depended on. These dependencies can give a rise to conflicts of interest and uncertain quality, or negative perceptions to newcomers and young people of the particular field. Generally, it is still not ready to solve the methodological problem of determining quality.

Also, Kostoff(1997) indicated the problem of peer review as these. First, peer reviews may include organizational or individual causes to influence the review outcomes by peer scientists in non-technical issues. Second, fields already with structured social networks tend to shield peers. Third, the criteria of evaluation and interpretation may differ to each reviewer. Fourth, the actual review task by peers is based on a premise that opinions are consent for what the respectable research is and what the emerging field is in the future.

2.2 Paradigm Shift of R&D Planning

The background for the rise of significance for research planning can be explained by the rapid increase in the scale of national R&D projects with the rediscovery of "planning" as a process for resolving pending problems, including the inefficiency of R&D within the process, confirmed empirically and the complication and expansion of R&D, and another aspect regards questions raised on how to overcome the current situation in which R&D environments such as technology advancement and acceleration are facing an extent of uncertainty.

The fact that R&D planning methods are developing into capturing new opportunities from the previous optimized utilization of resources, can be noticed by the modified focus of policy planning and operation planning to prior correspondence, referring to policy coordination between departments and related parties. For instance, prior planning actions such as technology impact analysis, technology standard evaluation and science technology forecasting is now clarified as regulations, with attempts of institutionalizing prior planning reports and preliminary validity examinations explaining this trend. The newly debated research planning paradigm can be summarized as the following table 1.

Also, the "Innovative system theory" based on science technology policies or innovation policies, is emphasizing on 'how to create new objects' rather than 'how should we allocate existing rare resources' as the government's role(Lundvall, 2006).

R&D itself is a series of analytic activities and relevant analysis information must be supported at the core of the operations. The utilization rate

Table 1. Forecast of modifications to national R&D systems

Period	Past	Present	Future
Features	- Based on Bottom-up method	- Bottom-up+Top-down - Optimized utilization of resources	-Searching/capturing innovative planning -Pursuing scientific planning methodology
Main details	- Technology pursuit planning - Researcher dependent planning - Mutual consent planning	- Planning with experts participating, for instance the demander of R&D results	-Comprehensiveapproach(technology pursuit + demand hauled+ socioeconomic goals) -Utilization of planning related methods including knowledge maps, prior validity assessments
Paradigm shift	Resource utilization centered → Plan originating centered		

Table 2. Weight of analysis for each analytic operation type

Analytic operation type	Details	Weight of analysis(%)	
		Expert	Information
Tech monitoring	Monitoring technology trends at all times, alerting when detecting abnormal changes	30	70
Information of competing technologies	Analysis of "who is researching what"	10	90
Technology forecast	Analysis of future technology development channels and promising fields	50	50
Technology roadmap	Analysis of linked cohesion channels of technology and related products	70	30
Technology impact assessment	Analysis of socioeconomic impacts of technology development	70	30
Technology prediction	Planning national strategic priorities and portfolios	60	40
Technology management	Selecting decision making administrator, analysis of participating personnel	60	40
Science technology index	Time analysis of technical capabilities for each nation	10	90

Reference : [Porter, 2005] modified

of information needs to be as significant as much as involvement of experts (refer to table 2).

Examples of utilizing results of information analysis and acknowledging its significance are increasing. Especially in Korea, the Ministry of Information and Communication is reflecting results from promising technology searches by information analysis, as in patent trend analysis and treatise quantitative analysis, for planning projects. In addition, experts for each field scouted through treatise and patent analysis are being allocated as project planning committees and assessment committees.

Ⅲ. Information Analysis Method and RADERS™ System

3.1 Information Analysis Method

3.1.1 Definition and Utilization

As in Figure 1, information analysis method refers to predicting movements in science technology and knowledge, by analyzing patterns and tendencies of information extracted from medium stored with knowledge and information of science technology. Academic articles(or patent information) from journals are important sources of information for research outcomes and quantitatively analyses extracted document databases which are recorded comprehensively, to estimate the trend of science development and connections between technologies. In this, knowledge maps and indexes are mainly used.

After the area of information analysis was introduced to the world, many scholars developed

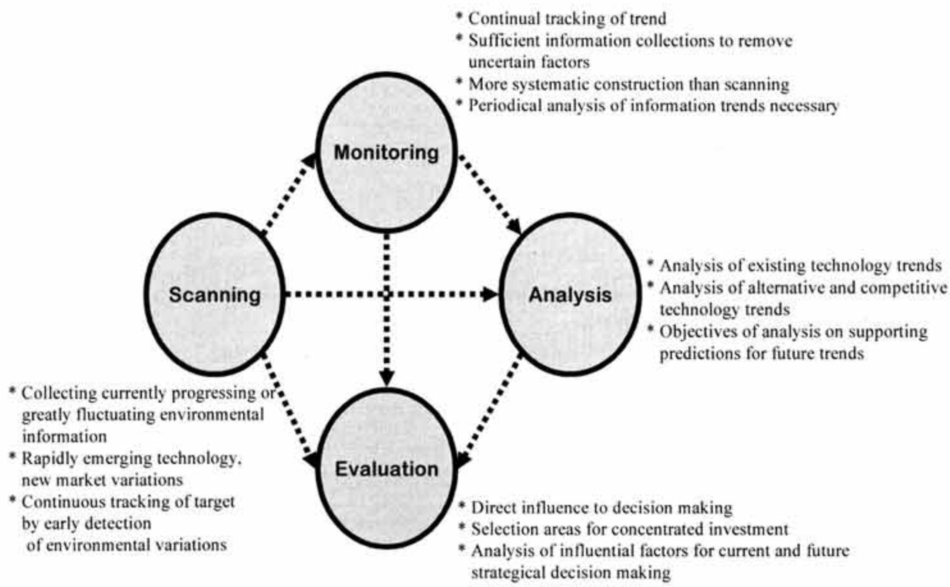


Figure 1. Role of Information Analysis Methods

indexes(for example, new technology research, discovering potential domain knowledge, connection between science and technology, movement of knowledge between academics, cooperation of researchers, etc.) and are using these up to date.

These various information analysis indexes presented by existing researchers can act to solve problems relating to "4W1H", a significant criteria for resource allocation decisions by research institutions, government agencies and companies.

Table 3. Utilization of Information Analysis

Research field	Research details	References
Research Period (When)	When are the ages of maturity and declination of research?	Leydesdorff & Hellsten(2006) Moed & Visser(2007) Leydesdorff & Zhou(2008)
Researching institution (Where)	Which institution is leading the research? With which institution is the research being joint?	Boyack, et al.(2001) Leydesdorff(2004) Leydesdorff & Sun(2008)
Main group (Who)	Who is leading the research? With whom is the research being joint?	Chen et al.(2007)
Researching Subject (What)	What research subject is under progress? What subject will be emerging? What subjects are being merged?	Mane & Borner(2004) Chen(2006) Porter et al.(2007) Lee(2008) Leydesdorff & Zhou(2008)
Research turnover (How)	How is the Paradigm Shift being occurring?	Chen(2005) Chen(2006)

3.1.2 Existing Information Analysis System

Information analysis that extracts beneficial knowledge from documentary databases(only documentary databases is being mentioned as the focus of this research is targeted mainly to academic studies, but also includes patents in a broader range.) is a time consuming task, requiring categorization of information and examination of hundreds of thousands of treatises(Chen, 2005). Therefore, manually generating treatise maps requires high costs with limited supply. So demands for automated analysis of generating treatise maps are extremely high. To live up to these demands, several software systems have been developed, being categorized into groups focusing on "visualized" methods and groups aiming for regular analysis. The table 4 is summarizing systems developed for analyzing treatises.

As it can be seen on the table, most well known systems focused on the process, are emphasizing on treatise search, analysis, visualization despite restrictions to utilizing certain systems for the treatise. These systems are considerably useful in effectively analysis the current data conditions, with its value proven by actual case analysis. However, it is difficult to identify systems including knowledge analyzing issues which are essential for assisting analysis of treatise mapping result and securing advantages of treatise mapping.

Treatise analyzing methods and mapping has been developed, now leading to the importance of directing future research to treatise mapping results and developing systems for analyze these. This is necessary for speeding up the overall process of analyzing results by enabling users unfamiliar to treatise maps(for example, policy devisers, general public, etc.) to acquire advantages.

Table 4. Existing Information Analysis System

System	Main Functions			Main Techniques
	S	A	M	
Aureka	■	■	■	Web-based, simple statistics, data mining, text mining, citation analysis
IPMap	■			Web-based, simple statistics
M-Cam Door	■			Linguistics genomic algorithm
VantagePoint™		■	■	Semantic analysis
STN®AnaVist™		■	■	Host-based, simple statistics, text mining, data mining
CiteSpaceII	■	■	■	Burst detection algorithm, citation analysis
Visone	■	■	■	Network data, Dynamic animation
BibTechMon™	■	■	■	Text mining, animation

Note) S:search(collection), A:analysis, M:mapping(visualization) Reference : (Lee et al., 2008) modified

3.2 RADERSTMSystem

3.2.1 Introduction

As stated above, the currently existing limitations of research planning, shortage of R&D budget and human resources lead us to the demands of developing a nationwide scaled information analyzing and forecasting methodology and structuring a system for organized analyzing of accumulated science technology and industrial information, to reduce effort and time required in R&D and technological development. Also, existing systems are mostly focusing on "visualization", therefore requiring development of systems for policy devisers and general public who are unskilled in manipulating data to utilize information analysis systems conveniently.

For this, KIAT(Korea Institute for Advancement of Technology) has applied R&D related information as ground data to develop RADERS™(Research Area DEtection through R&d information Scanning), which is a national scaled R&D information analysis system to reduce time and effort for research and development. RADERS™ has been applied for a Korean patent(Information analysis system and methodology, 10-2007-0100222, 2007), US patent(Information Analysis System, 11953574, 2007), trademark registration and program registration.

3.2.2 Application

The proposed architecture is consisted of three processes in information extraction, pattern recognition, and visualization. The information extraction process includes three engines; context extraction, co-authorship analysis, and co-word analysis. Each engine is utilized as devices to extract valuable information from main documents.

The objective of the pattern recognition process is to distinguish important patterns that can be used for support in decision making. This also is consisted of three engines; subject category, working group, and impact assessment. Subject Category engine, which is to aid policy planners to understand research domains, will detect research headings from domains, identify the deployment of research domains, extract key concepts and measurable items from each discipline, and structure a network relationship amongst core concepts. Meanwhile, The Working Group engine identifies working groups and its leaders, while assessing the mobility of each group which aided policy planners in deciding examination of supported proposals, and also evaluates the reliability of researchers and efficiency of previously approved support. The Impact Assessment engine scrutinizes the impact of researchers, groups, or recommended domain experts and potential cooperators. This engine aids policy planners to identify the core players of the domain and unveil academics that connect research from other fields.

The next visualization process is the only section with interaction between policy planners.

Significance of this stage roots from the complexity of the second process and high-dimensional characteristics of distinguished patterns. Many difficulties exist for policy planners to understand the patterns without any visual aid.

Developed within these concepts, RADERS™ can be applied to 4 different fields. As in Figure 5, first, objective information for the following headings is provided in R&D task planning. Exactly, information of technology development conditions, emerging technology, centrally raisable technology, our advantages and disadvantages, leading researcher or rising researcher, leading research group or rising research group, cooperation levels between countries and our situation, and the moldability with other fields. Second, objective task planning and efficient resource allocation is possible. Third, the objectiveness of pools of experts helpful in planning stages for each field, can now be secured. Fourth, technological information can be provided to small and medium enterprises and universities that lack information of new technologies.

Ⅳ. Case study : Searching for emerging technology

4.1 Definition of searching for emerging technology

In this article, the search for emerging technology is defined in two ways of emerging technology detection and emerging trend detection. First, emerging technology detection refers to a comprehensive detection of new information or new trends. In detail, it can be divided into novelty detection and emerging trend detection. Here, novelty detection regards to detecting unprecedented information from a particular point of time, and emerging trend detection refers to understanding new trends not from a particular point of time but in a relatively

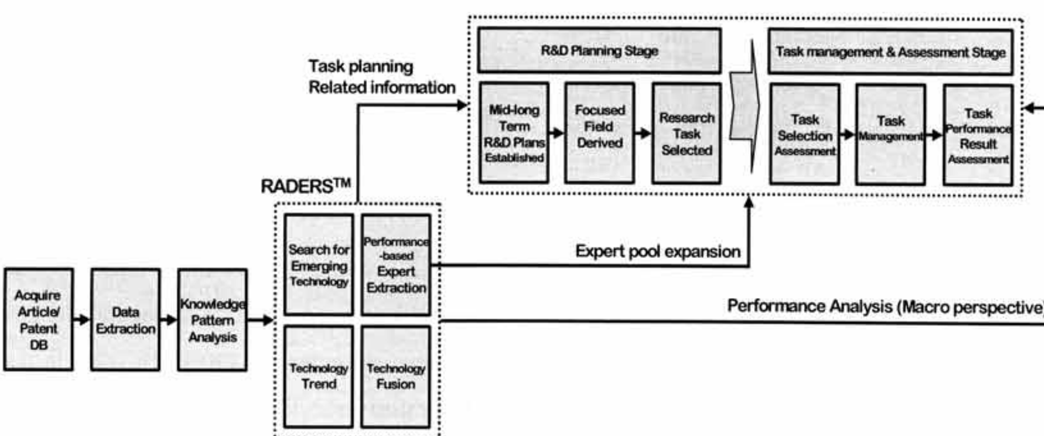


Figure 2. Application sphere of RADERSTM

longer period of time.

Second, emerging trends, as in emerging trend detection, can be defined as research subjects with incrementing interests and utility as time flows. Therefore, detecting these emerging trends can be seen as examining the phases of differentiation according to a time period in a mid-long term perspective, leading to detection of trends and inclinations of specific academic fields. This emerging trend detection can be explained as newly developing technology. The newly developing technology being described here refers to developing/improving or newly up swinging cases from positive modifications to existing themes, so these new technologies must basically be a part of existing themes but with positive developments under progress recently. With this as a premise, newly developing technology has the following two features(Kontostathis et al., 2003). First, as the significance is more exuberant after rather then before a particular point of time, key words that appear simultaneously with the new technology increase greatly. Second, as the related items(documents) for the corresponding concept or theme increases in number, so does the frequency of appearance.

4.2 Analysis process for detection of emerging technology

In this research, co-word analysis is used to search for emerging technologies. This method is an effective content analysis method for indicating the intensity of relations between text based data keywords. Co-word analysis reduces the technical term(keyword) spaces into network graph sets and clearly explains the connections between the most intense technical terms(Coulter et al., 1998; Whittaker, 1989). Co-word analysis is one of the graphical modeling methods applied with relation analysis concepts(Edwards, 1995; Kaufman and Rousseeuw, 1990).

4.2.1 Data Input

Representative key words of the analyzing subjects are input into WoS(Web of Science) to retrieve related articles. Fields necessary for analysis are author, keyword, article title and year.

4.2.2 Key Word Extraction

After data is input, key words are extracted from fields including author, keyword, article title and year by RADERSTM, based on related treatises(Cambrosio, et al., 1993, Voutilainen, 1993). Data recalled in this way comprise ground data for the analyzing subject.

4.2.3 Key Word Cleansing

Data Cleansing is performed based on the extracted key words. This operation corrects key words that are expressed differently, despite the fact that they possess identical definitions(Ding et al., 2001).

For instance, if the result of article search turns out to be Information(10 articles), Informations(6 articles); KIAT(10 articles), Korea Institute for Advancement of Technology(6 articles), these all refer to the same subject but are recognized as different items. If the revision process isn't undergone, system recognizes these as 4 different key words and performs calculations accordingly.

By executing data cleansing, Information(10 articles) and Informations(6 articles) are combined into Information(16 articles), KIAT(10 articles) and Korea Institute for Advancement of Technology(6 articles) are combined into KIAT(16 articles) resulting in the chance of significance for the key words Information and KIAT. Consequently, similar key words are bound up into one category to minimize errors in calculations.

4.2.4 Detecting emerging technology

Following the data cleansing process, emerging technology is detected upon this. In this process, newly appearing technology and newly noticeable technology" is searched for.

To being with, the newly appearing technology searches for new emerging key words in the recent 2 years, not considering the frequency. Next, newly noticeable technology applies a diagram proposed by Porter[2000] to detect. As in Figure 3, axis X refers to growth rate, axis Y refers to number of treatises, and each quarter of the diagram is named as declining area, growing area, maturing area and emerging area.

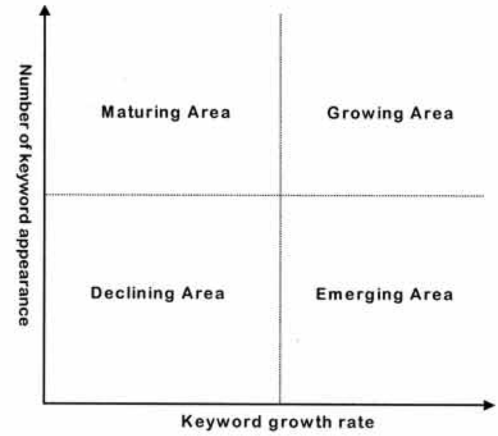


Figure 3. Analyzing diagram for detecting future emerging technology

Key word growth rates and average number of appearances are applied as criteria for classifying these areas. Averages are being used as there are insufficient accumulations of analyzed cases currently, but soon when accumulations become sufficient averages for each field are planning to be utilized.

The emerging area named in the diagram can be defined as having low numbers of appearance but rapidly increasing growth rates in recent years. In this case, growth rates can be referred to the following formula.

Growth rate = Slope from recent data(Ex., 2004~2008)/Slope from all data(Ex., 2002~2008)

4.3 Analysis Result

4.3.1 Range and unit of analysis

An analysis was performed for the 10 technologies proposed as strategic fields by the

Ministry of Knowledge Economy, that is, semiconductor, display, digital broadcasting, mobile communication, BcN, new generation computing, SW solution, digital contents, embedded SW and knowledge information security.

The unit of analysis for detecting emerging technology is like the following. First, the overall growth rate of the 10 technologies and growth rate for the emerging area is calculated. From this, the technology(within the 10 technologies) with the highest growth rate in the emerging area is selected. Finally, technologies that affiliate with the emerging area are extracted, and the 10 technologies are then ultimately rounded up from these.

4.3.2 Technical analysis of the 10 technologies

To search for SCIE(Science Citation Index Expanded) article regarding the 10 technologies, selecting representative key words for each field must be preceded. For this, key words that represent each technology was acquired from the Korea Institution of Patent Information (www.kipi.or.kr).

The result of searches(2002.01~2008.08) on WoS(Web of Science) for the key words of the top 10 technologies are displayed in the following Figure 4. From the outcome, the number of articles for all technologies seem to be gradually increasing, with an exception of 2008. Also, article is most abundant in the semiconductor field, and is followed by knowledge information security and digital broadcasting technology.

4.3.3 Detecting emerging technology

Based on key words(refers to author key word

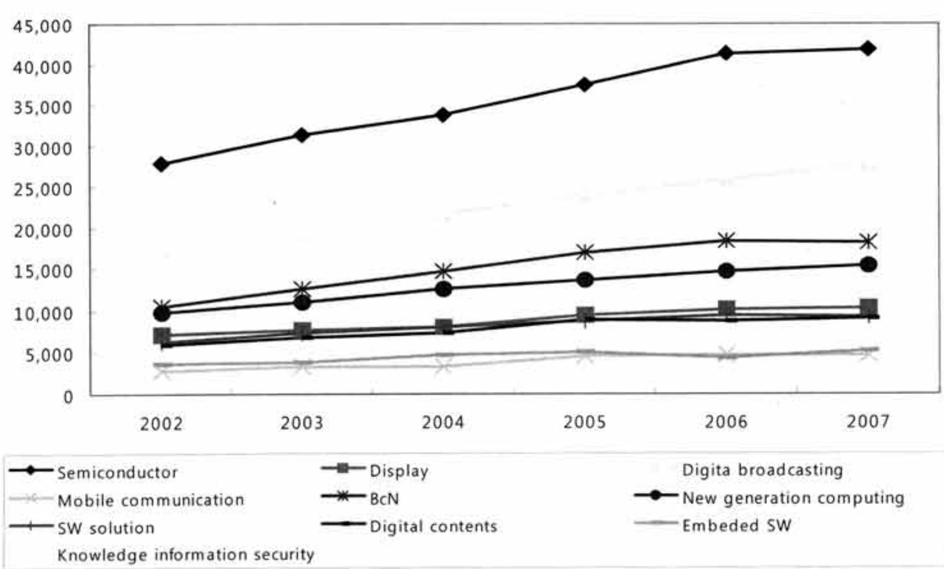


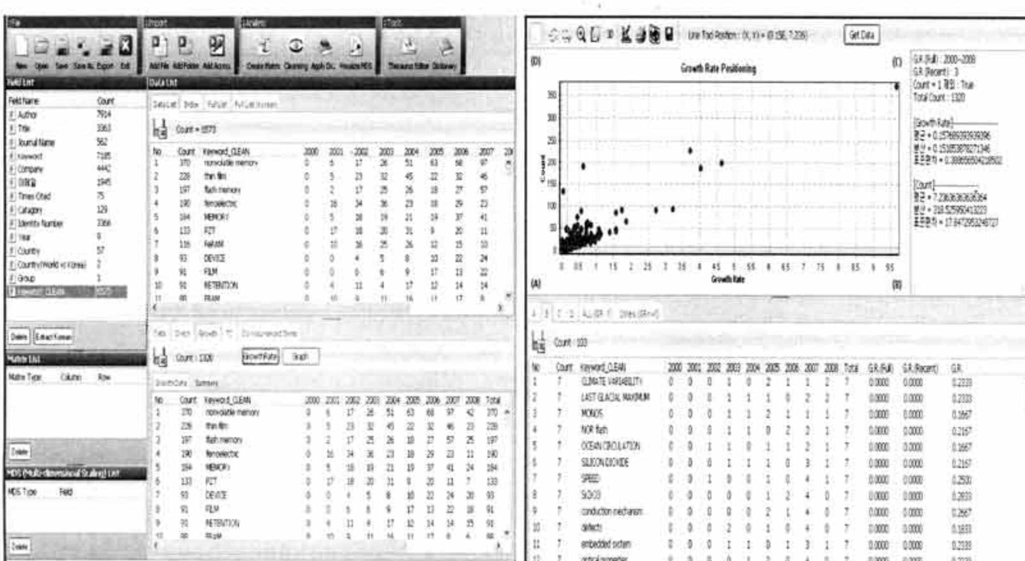
Figure 4. Annual number of articles for 10 technologies

fields in SCI) extracted from treatise search, a data cleansing process that combines key words with identical meanings is performed before detecting emerging technologies. When this process is completed, emerging technologies can be searched for. In this study, emerging technologies are defined as newly noticeable technologies. As a result, the RADERS™ system displays newly noticeable technologies through a growth rate estimation of the analyzing subject.

To verify promising technologies detected by this research, final results were concluded after undergoing debates for validity and realization possibilities of outcomes generated from RADERS™ with 2 university professors and related business professionals in the display field, which ranked highest among the top 10 average growth rates of technologies.

The small box in Figure 5(a) is a growth rate estimation dialog box in which the analyst can manipulate the formula according to the characteristics of the field. When the estimations are done, a diagram that indicates that emerging technologies can be detected is shown as in Figure 5(b). At this point, the criteria that divides each area on the diagram is applied as growth rate averages in axis X and average number of treatises in axis Y.

By analyzing the overall growth rate of each technology and the growth rate of technologies included in each emerging area(refer to Figure 6.), it can be understood that the display technology excels in growth rate throughout the overall growth rates.



(a) RADERS™ main screen (b) Emerging technology detecting diagram

Figure 5. Emerging technology detection through RADERS™

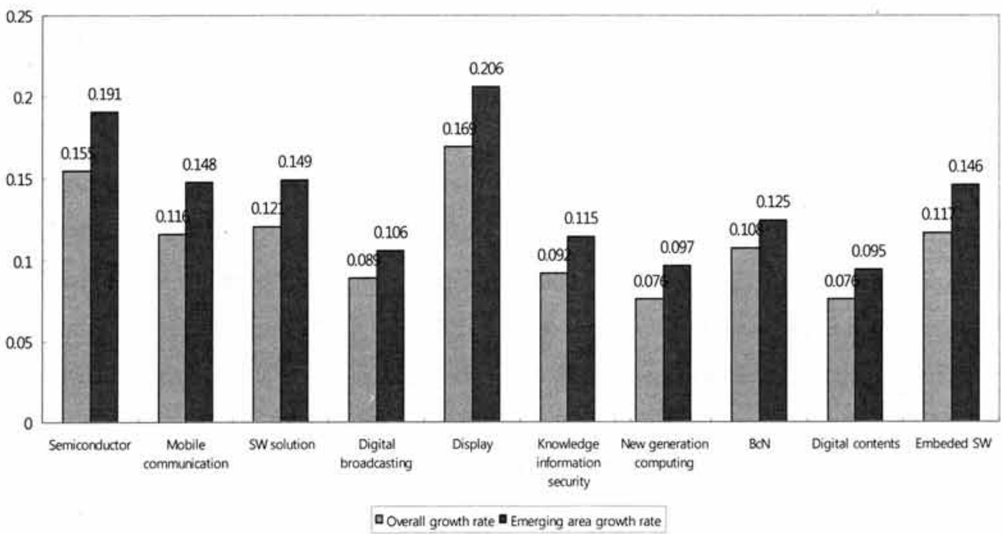


Figure 6. Average growth rate of each 10 technology and growth rate of emerging areas

The display technology, with the highest growth rate within the 10 technologies and emerging area, is specifically classified into 5 middle categories each with 17 detailed categories. With this categorized data, the overall growth rate and growth rate of emerging areas was

표 8 Table 5. Detailed categories and growth rate of display technology

	Detailed categories of display technology	Overall growth rate	Emerging area growth rate
Actual 3 Dimensional Display	3D display	0.097	0.115
	3D image acquiring, interaction system	0.088	0.108
	Actual 3 dimensional display system	0.100	0.123
	Laser Display component	0.055	0.071
	Laser Display System	0.083	0.102
Flexible Display	Flexible Display Module designing technology	0.087	0.110
	Flexible Display material technology	0.080	0.101
	Flexible Display device designing technology	0.116	0.141
LCD	High-credible material	0.1089	0.137
	Large area high resolution TV & DID technology	0.092	0.113
	New generation process for LCD device technology	0.0967	0.111
OLED	Process and equipment components	0.088	0.110
	Large size module, small size module for AMOLED	0.126	0.153
	Process devices for AMOLED	0.119	0.148
PDP	Large size high resolution PDP module designing technology	0.120	0.150
	New generation process PDP device	0.136	0.172
	Eco-friendly high-credible material	0.118	0.143

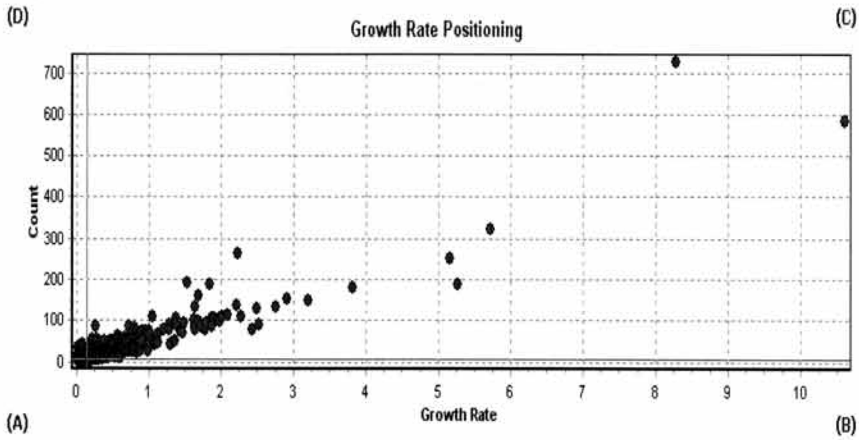


Figure 7. Strategic diagram of "new generation process PDP device" technology

analyzed(refer to Table 5).

In the analysis results, "process device for AMOLED" from the "OLED" field had the highest overall growth rate, and the "new generation process PDP device" technology in the "PDP" field had the highest emerging area growth rate. As in these results, the growth for the overall data and that for emerging areas differed but the "new generation process PDP device" technology in the "PDP" field was selected finally as the emerging technology.

Finally, the emerging technologies for "new generation process PDP device" were searched. Figure 7 is the strategic diagram result from an analysis by RADERSTM. In this figure, (b) area is the emerging technology. There are 343 technologies included in this area, with an average numbers of 5.14 treatises and average growth rates of 0.186. Out of these technologies, the top 10 were ultimately selected as emerging technologies(refer to Table 6).

Table 6. Emerging technologies of new generation process PDP device(top 10)

Technology title	Number of Article	Growth rate
Singlet Oxygen	6	0.266
Helicon Discharge	7	0.260
Gliding arc discharge	7	0.260
Standing-wave	7	0.248
Micro arc oxidation	7	0.212
Bacillus-Subtilis Spores	6	0.206
Secondary electron emission	7	0.2
Pulsed-Laser Deposition	6	0.181
Amorphous Hydrogenated Carbon	7	0.151
Laser-Absorption Spectroscopy	3	0.151

4.4 Discussion

RADERS™ can be used to detect and visualize rapid changes to research fields and newly emerging trends for various users, especially scientists and scientific policy researchers, policy devisers and students. Also, strategic diagrams for detecting promising technologies may be utilized to examining mechanical relations between specialties.

Within the same visualization, totally integrated strategic diagrams possess two practical advantages. First, not just searching for promising technology simply with the number of words appearing simultaneously, but detecting technologies with calculated growth rates based on appearance frequencies of the recent year, may be more beneficial to researchers. Second, attempting strategic diagram methods can supplement the disadvantages of co-word analysis.

For the long run, the co-word analysis method used in this research to detect promising technologies needs to be improved. Co-words are known as transporters of definitions across unrelated fields such as science, technology, social studies. But words and co-words grasp its definition within a sentence, while sentences obtain its definition within a paragraph[Leydesdorff & Hellsten, 2006]. That is, a problem of linguistic vagueness exists despite different academic backgrounds and research agendas. The relation between words possess different definitions in separate context, as the word meanings may be altered.

In spite of this, there was little effort in this research to resolve these problems of co-words. Therefore, next-order mechanism for definition exchanging must be developed in the future for research on word arrangement modifications and changes to definitions and relations between words.

In this research, RADERS™ has been depicted as a system for detecting promising technology easily by analyzing massive quantities of treatise data. There may be a few possible directions to expand this research. For instance, research treatise and connections between patterns were primary themes for policy researching, scientific and technological indexes, and fields such as knowledge diffusion. But many more research fields may exist including fusion, cooperative research between nations and institutions, also requiring tools for large masses of data to convert into open and beneficial messages.

Ⅴ. Conclusion

The rapidly fluctuating R&D environment with radical progress in fusion compounding, reduced life span of technology and products, change in R&D reputation of Korea, has intensified the significance of strategic technology planning.

In this study, an information analysis method was proposed for the consolidation of research planning and introduced an information analysis system, RADERS™, to reinforce this. Further on, case analysis of RADERS™ applications were performed.

In the future, preliminary technology planning will be connected/reflected into technology development roadmaps to substantial the search for new task operations for each field. Also, for pending questions lodged to task candidates, the record·vintage will be examined for knowledge utilized in RADERS™ to inspect the validity in multiple perspectives.

This study holds the following limits. First, the appropriateness of analyzed data. SCIE from WoS, which possesses a collection of analyzed data was used in this study. Regarding the characteristics of case studies, patent data should have been used apart from treatise data. However, patent data has not been reflected in this analysis. Characteristics of applicable patent data needs to be understood to utilize both treatise data and patent data in future research of emerging technology. Second, the absence of visualization analysis (RADERS™ is equipped with visualization functions). Precisely, this study applied Porter's diagram to detect emerging technology. By using this method, it is true that the possibility of the analyst's subjectivity interfering is minimized as well as the fact that detecting emerging technology is conducted more promptly, due to analysis based on numeric. However, in general, information analysis methods should induce results from visualization and interpretations by analysts are usually conducted from these. Therefore, efforts are necessary in the future to display the target field in visuals, for research of emerging technology. Third, comparisons with existing detection methods are necessary to guarantee objectivity of the RADERS™ system. Fourth, detailed categorization is needed for emerging technologies resulting from these methodologies. That is, emerging technologies induced from these methods could literally be theoretically realizable, or technologies that could possible be realized but in the too far future. Therefore, efforts to classify these emerging technologies through detailed categorization is demanded.

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현재 한국산업기술진흥원(KIAT) 정책기획팀 선임연구원으로 재직 중이다. 한국외국어대학교에서 경영학 박사(2002) 학위를 취득하였다. 과학기술정책연구원(STEPI) 신기술경제성분석연구센터 부연구위원(2004)으로 재직하였으며, Boston University에서 박사 후 과정(2005)을 수행하였다. 주요 관심분야는 계량정보분석, Bibliometrics, Technometrics, R&D 정책 등이다.

이명호(Myoung Ho LEE)

현재 한국외국어대학교 글로벌경영대학 교수로 재직 중이며, 한국고객만족경영학회 편집위원장을 맡고 있다. 서울대학교 공과대학 원자핵공학과에서 학사, 서울대학교 대학원 경영학 석사, 미국 캔사스주립대에서 산업공학 석사를, 미국 죠지아공대에서 산업/시스템공학 박사를 취득하였다. 관심분야는 경영혁신,생산전략, 시스템 다이나믹스 등이다.

박준철(Jun Cheul PARK)

대구대학교 경영학과에서 학사, 한국외국어대학교 경영정보대학원 경영정보학과에서 석사, 대구대학교 대학원 경영학과에서 박사학위를 받고, 현재 강릉원주대학교 산업정보경영공학과 부교수로 재직 중이다. 주요관심분야는 e-business, 인터넷 소비자행동, 기술가치평가 등에 관심을 가지고 있다.

요약

선도 R&D 계획에 관한 계량서지분석; 과학문헌에서의 유망동향 탐색

이우형 · 이명호 · 박준철

승자독식(Winner Takes All) 이라는 글로벌 경쟁원리로 인해 세계 주요 국가들 사이에 R&D 경쟁이 갈수록 치열해지고 있다. 이에 우리나라에서도 R&D 지원 확대 및 다양한 정책기획 활동 등이 전개되었다. 이러한 노력에도 불구하고 국가 차원에서 기획 및 정책조정이 효과적으로 추진되지 못하고 있으며, 국가연구개발사업 차원에서는 "기획의 양적 과다와 질적 부실"이라는 비판이 제기되고 있다.

반면에 기술 융복합화의 가속화 등 R&D 환경의 불확실성은 더욱 높아졌으며 국가연구개발사업의 규모 증가와 함께 연구기획의 복잡성은 더욱 더 높아졌다. 최근에는 국가 차원의 비전수립과 중장기 정책기획에 기초하여 사업기획과 과제기획을 연계 수행하는 등 기획을 통해 과제를 도출하는 하향식 접근이 강조되면서 기획의 중요성은 더욱 커졌다.

최근 연구기획의 새로운 기법으로서 정보분석 방법론(Information Analysis Method)이 대두되고 있다. 국가연구개발사업의 효율적 기획을 위하여 기존 기술기획 위원회(Peer Review) 방식 외에 정보분석 방법론을 통한 보완이 필요하다

본고의 목적은 크게 두 가지로 설명할 수 있다. 첫째, 현재 진행되고 있는 연구기획 및 연구기획 방법론으로 가장 많이 활용되고 있는 전문가 위원회의 한계를 제시하였다. 둘째, 최근 대두되고 있는 정보분석 방법론과 정보분석 시스템 구축, 그리고 이를 활용한 10대 기술(반도체, 디스플레이, 디지털 방송/전파, 이동통신, BcN, 차세대 컴퓨팅, SW솔류션, 디지털콘텐츠, 임베디드 SW, 지식정보보안)에 대한 유망기술 발굴 실증분석을 실시하였다.

Keywords : R&D Planning, Emerging Trends, Scientific Literatures, Bibliometrics, RADERS^{TM}

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