

A Study on the Improvement of National R&D Project Performance Evaluation and Budgeting System

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Abstract The national R&D project is a major strategy for the development of science and technology in the country. This is promoted for the purpose of improving the welfare of the people, such as creating jobs and fostering small and medium-sized enterprises, through the results of science and technology research conducted with support from the national budget. Therefore, analysis of the performance evaluation and budgeting system of the current national R&D project is one of the essential parts of preparing a system improvement plan.

This study derived improvement plans through a comparative analysis of national R&D project performance evaluation and budget systems in Korea and leading countries such as the United States and Japan. As a result, it was confirmed that it may be difficult to derive innovative research results due to the lack of sustainability and a short period of time to require quantitative performance. To overcome these difficulties, the need for system improvement as follows was suggested. First, it is necessary to enlarge and prolong national R&D projects. Second, a plan for securing sustainability is needed in consideration of the main characteristics of each research field. Finally, it is necessary to strengthen the linkage between organizations in charge of national R&D projects. And also, there is a need for a system that can continuously identify problems and improve the system. In addition, the constitutional amendment will be necessary to separate science and technology from economic development, which states that Article 127, Paragraph 1, “Science and technology should be subordinated to economic development,” which is the science and technology article of the current constitution.

Keywords: National R&D Project, Performance Evaluation, Budgeting System, Case Analysis

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1. Introduction

National R&D projects are carried out in most countries to strengthen national science and technology competitiveness, economic development and improvement of people's quality of life. Based on the 「Framework Act on Science and Technology」, the Republic of Korea (ROK) sets the national R&D budget through an adjustment process through project performance evaluation. The ROK national R&D project performance evaluation system has been applied since 1999. In 2005, the system of national R&D performance evaluation was established through the enactment of the 「Act on Performance Evaluation and Performance Management of National R&D Projects」. From 2005 to 2021, continuous system improvement was pursued with the 「Basic Plan for National R&D Performance Evaluation」. It is a policy that directly supports the national budget for R&D. This policy is an act of the state intervening to overcome market failure. Also, this is a national project carried out through cooperation between national research institutes, universities, and private companies.

In national R&D projects, cooperation between ministries is important, and budget adjustment between ministries is a very sensitive issue. However, the budget system continued to change every time the regime was replaced, so there was an obstacle to cooperation between ministries. The most recent performance evaluation system for national R&D projects consists of self-evaluation in charge of each ministry and high-level evaluation in charge of the Ministry of Science and ICT (MSIT). In addition, the budgeting system for national R&D projects is pre-arranged by the Presidential Advisory Council on Science and Technology (PACST) based on Article 9 of the 「Framework Act on Science and Technology」.

In this study, with the background of previous research related to national R&D projects, a qualitative research method was used for an in-depth understanding of specific cases such as a review of performance evaluation and budget system and analysis of the status of each country's performance evaluation and budgeting system (i.e., the case study method). To respond to the era of the 4th industrial revolution, previous studies and the current status of each country were analyzed for improvement of performance evaluation and budgeting system in ROK. In particular, based on the results of analyzing differences in the United States (U.S.) and Japan, it was intended to improve the performance evaluation and budgeting system of the ROK's national R&D projects. The structure of this study is as follows. Chapter 2 reviews the

theoretical discussion and previous research related to the national R&D project. Chapter 3 introduces the analysis overview, methodology, and structure of this study. Chapters 4 and 5 analyze the status of each country's performance evaluation and budgeting system. Finally, Chapter 6 specifies the conclusions and implications of this study.

2. A Theoretical Discussion

2.1. Concept of National R&D Projects (Performance Evaluation)

Performance evaluation of national R&D projects is stipulated in Article 2 (definition) of the 「Act on Performance Evaluation and Performance Management of National R&D Projects, etc.」. Performance evaluation can be defined as evaluating the level of achievement of goals according to indicators. In particular, the purpose of ROK's national R&D project performance evaluation is to measure the level of achievement of R&D goals. The implementation of performance evaluation has the advantage of suggesting a policy direction suitable for the promotion of national R&D projects. In related legislation, evaluation is defined as an activity that measures the level of achievement of goals according to indicators. Certain criteria are important for R&D performance evaluation. Accordingly, performance evaluation can be performed using a particular criterion as an indicator. As a result, activities that measure the level of goals achieved can be defined as performance evaluations of national R&D projects. Figure 1 shows the basic procedure of performance evaluation.

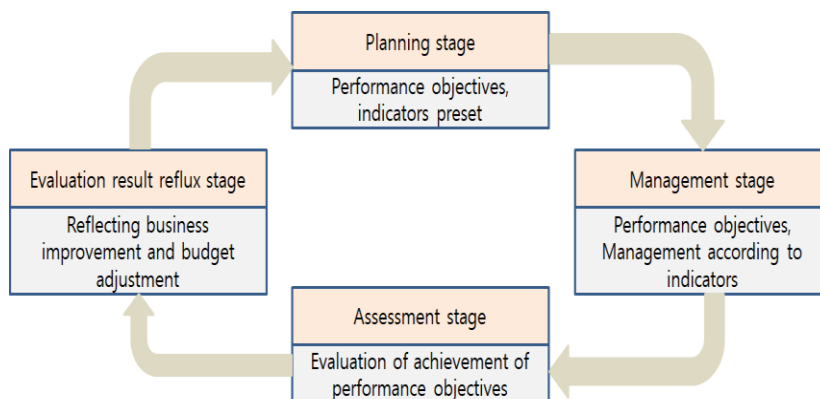


Figure 1: Basic Procedures for Evaluation of National R&D Projects

Source: Ministry of Science and ICT (2020)

The purpose of the evaluation is divided into two parts. First, it is to obtain useful information for policy-effective decision-making. Second, evaluation is performed to derive priorities for practical-effective decision-making and improvement items for evaluation targets. In recent years, the national R&D project has gradually emphasized the aspect of performance management to derive improvements rather than priorities. As shown in <Table 1>, the national R&D project performance evaluation system is divided into three categories: project evaluation, assignment evaluation and institutional evaluation (MSIT, 2020).

Table 1: National R&D Project Performance Evaluation System

Category	Objective	Evaluation
Project Evaluation	Improvement of project and allocation and adjustment of R&D budget by assessment of project performance	Evaluation of research and development projects promoted by ministries (self-evaluation) and innovation headquarters (superior evaluation)
Assignments Evaluation	Identify the performance of R&D projects and ensure accountability of the research process	Evaluation of R&D tasks performed by researchers by the competent ministries
Institutional Evaluation	Performance inspection and development direction based on agency roles and responsibilities (R&R)	Research and development projects (contribution + government entrusted) conducted by research institutes (25 under the jurisdiction of the research association and 21 under the direct control of ministries) and the management of institutions are evaluated by ministries, research associations (self-evaluation) and innovation headquarters (higher evaluation)

Source: Reconfigured by Ministry of Science and ICT (2020).

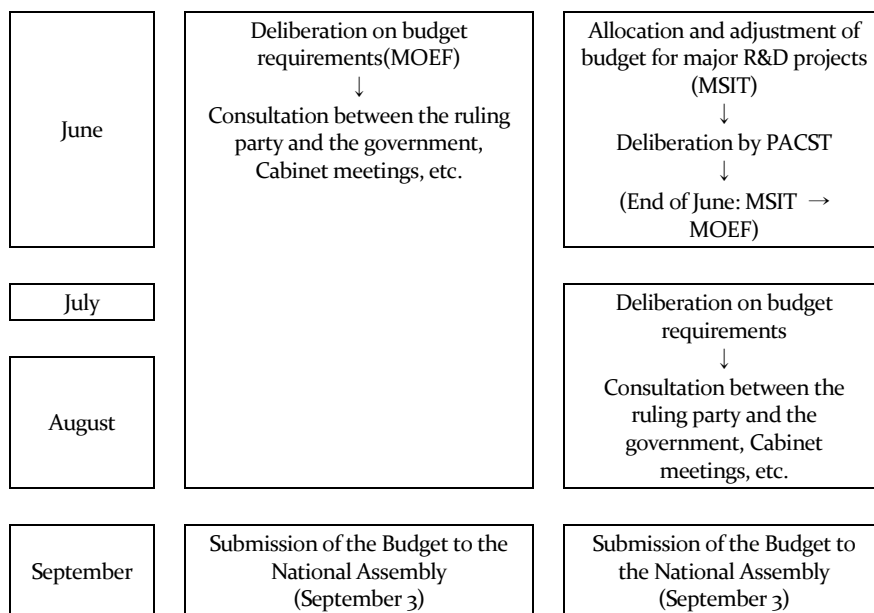
2.2. Concept of National R&D Projects (Budgeting System)

Budgeting for national R&D projects is different from general budgeting. According to Article 11 of the National Finance Act, The Minister of Strategy and Finance is generally in charge of budget affairs (National Assembly Budget Office: NABO, 2019). For budgeting, the head of each agency shall submit a mid- to long-term business plan (under Article 28 of the National Finance Act) and budget request (under Article 31 of the National Finance Act) to the Minister of Strategy and Finance. “Thereafter, the Minister of Strategy and Finance will compile a budget and submit it to the National Assembly 120 days before the

fiscal year with the approval of the President after deliberation by the State Council (NABO, 2019).” Especially the R&D budget is allocated and adjusted by MSIT based on Article 12-2 of the Framework Act on Science and Technology. The head of the central administrative agency shall submit to the MSIT opinions on investment priorities of national R&D projects, mid-term business plans related to national R&D projects, and budget requests related to national R&D projects for the following year. MSIT shall notify the Minister of Strategy and Finance and the heads of relevant central administrative agencies of the direction and standards of government R&D investment by March 15 each year. Also, MIST reviews the R&D project budget request and informs the Ministry of Economy and Finance (MOEF) of the investment priorities by sector, the direction of national R&D project budget allocation, and the adjustment of major national R&D project budgets after deliberation by the PACST (NABO, 2019).

Table 2: The Process of formulating the National R&D budget

	General R&D budget	Major R&D budget
October of the previous year		R&D investment priority opinion for the next year (End of October: Each ministry → MSIT)
January	Submission of mid- to long-term business plan (End of January: Each ministry → MOEF)	Submission of mid- to long-term business plan related to R&D (End of January: Each ministry → MSIT)
April	Notification of budget draft guidelines (end of March: MOEF→ Each ministry)	Notification of Government R&D Investment Direction and Criteria (March 15: MSIT → MOEF, Each ministry)
May	Submission of budget (including funds) request (End of May: Each ministry → MOEF)	Submission of R&D budget request (End of May: Each ministry → MSIT, MOEF)



Source: National Assembly Budget Office, (2019).

The national R&D budget of each ministry is coordinated by MOEF and MSIT. The major R&D budget is adjusted by MSIT, and the MOEF reflects the results of the adjustment of the main R&D budget of the MSIT to formulate the final R&D budget together with the general R&D budget. The general R&D budget adjusted by the MOEF includes R&D projects in the humanities and social sciences, operating expenses of government-funded research institutes and public research institutes, and policy research expenses. The major R&D budget includes R&D projects such as basic source technology and applied technology development, R&D project expenses of government-funded research institutes and public research institutes, and facility equipment construction projects. And the major R&D budget is adjusted by the MSIT in accordance with Article 21 (3) of the Enforcement Decree of the Framework Act on Science and Technology.

Table 3: Government R&D Budget Status

Category		2020 (A)	2021 (B)	Increase and Decrease	
				(B-A)	(B-A)/A
Government R&D		242,195	274,005	31,810	13.1
Major R&D	Amount	197,314	224,894	27,580	14.0
	Percentage	81.5	82.1	0.6	-
General R&D	Amount	44,881	49,112	4,231	0.4
	Percentage	18.5	17.9	0.6	-

Notes: Unit (a hundred million won)

Source: Ministry of Science and ICT (2021).

2.3. Review of Previous Studies

Research on the performance evaluation and budgeting system of national R&D projects in ROK has been actively conducted since the enactment of the 「Act on Performance Evaluation and Performance Management of National R&D Projects」 in 2005. In a study conducted by Kang (2020), it was confirmed that the types of national R&D project budgeting processes differed by regime. It was confirmed that the existing R&D budget system had changed when a new leader who emerged as a change in the regime expressed a strong intention. Hong (2018) derived implications for using evaluation systems, policy evaluation, evaluation methodology, and evaluation results through the analysis of national R&D project evaluation systems and evaluation cases in advanced technology countries such as the United States and Japan. Also, Hong (2018) confirmed the need for a continuous and systematic redesign of the evaluation system to enhance the effectiveness of national R&D project evaluation. In addition, it was confirmed that establishing a national R&D evaluation information system was necessary as infrastructure to utilize the evaluation results was necessary. A study by Yoo (2016) confirmed that although a system linking performance evaluation and budgeting was in place, it was not effective enough. This problem was identified as the lack of objective judgment standards and systems for the judgment criteria for national R&D investment. Accordingly, three implications were presented as a part of improving the national R&D project performance evaluation system. First, the establishment of a system supplementation and review system is needed for linking the performance evaluation and budgeting of national R&D projects. Second, it is to establish a mid- to long-term National Technology RoadMap (NTRM) for national R&D projects with a differentiated performance evaluation system for each stage of the project. Third, it was suggested that performance evaluation should be

carried out that includes differentiation for each project by strengthening self-evaluation of national R&D projects and establishing a performance evaluation indicator system. A study by Kim et al. (2013) confirmed that countries with active government R&D investment activities such as the U.S. and Japan are striving to come up with alternatives to improve the expertise and effectiveness of evaluation. To this end, it was stated that it would be desirable to strengthen the presentation of directions, including the basic principles of evaluation, so that efficient evaluation can proceed in terms of the purpose of evaluation and the use of results. Second, it was stated that it is important to actively participate in international evaluation research activities to secure and disseminate the latest trends and advanced methods related to national R&D project evaluation and policy evaluation. Third, it stipulates that it is necessary to establish an evaluation infrastructure for national R&D projects to strengthen R&D evaluation capabilities and systematically foster professionals. Lee (2012) confirmed that the performance management system was operated individually even though it was based on the organic linkage of the evaluation and budget system. In particular, the budget for the national R&D project performance evaluation results is not reflected compared to actual expectations because the results of reliable performance information are not directly linked to the budget. In addition, in the process of the budgeting system, if budgeting is carried out by political logic, the results of performance evaluation and budgeting will not be linked. According to Kim (2010), the National Science and Technology Committee (NSTC) is in charge of a comprehensive adjustment function for the formation of R&D projects and the effective operation of the budget. However, it was pointed out that the direction of budget planning and budgeting is not organically linked because MOEF and NSTC are individually involved. In addition, since there is no actual control agency for science and technology policy, it is necessary to prepare countermeasures for operating these functions. As a new budgeting method to replace the existing science and technology innovation headquarters system, MOEF and NSTC presented an efficient linkage method and the effective comprehensive adjustment method of the science and technology policy of ROK. As a result of reviewing previous studies, it was confirmed that research was conducted through various measures to evaluate the performance of national R&D projects and upgrade the budgeting system. However, there have been few cases of conducting comparative studies with other countries in terms of performance evaluation and budgeting. In fact, the performance evaluation and budgeting system of national R&D projects in ROK are greatly influenced by the U.S. and Japan. In particular, in the case of the U.S., since it maintains friendly national relations with ROK, it can be seen that it is very meaningful to analyze and review the performance evaluation and budgeting system of the U.S. In addition, as a neighboring country, Japan's national R&D project performance evaluation and budgeting system have

similar differences to that of ROK. Based on these characteristics, the U.S. and Japan were selected as comparative countries and studied.

3. Research Overview

This study utilizes a case study method, one of the qualitative research methods that can understand the current status and characteristics of a specific case in depth. By comparing the performance evaluation and budgeting systems in the U.S. and Japan, we intend to discover the case characteristics of ROK more clearly. (Stake, 1995) defines case studies as “studying the specificity and complexity of one case to understand the activity of the case within the main context.” In addition, Stake (1995, 2006, 2008) and Merriam (2009) stated that the case should have boundness, systematicity, specificity, and complexity (Park et al., 2020; Lee, 2020). The performance evaluation and budgeting system of national R&D projects is an independent system with boundaries and can be considered suitable for boundary and systematicity because it is carried out for each purpose. In addition, the national R&D project performance evaluation and budgeting system is a system related to various ministries such as MSIT, MOEF, and PACST, and has the characteristic complexity of case studies. The purpose of the case study is to understand the case in depth. Case studies that allow a deep understanding of a particular case are said to be useful, especially in evaluating a particular program and in proposing policies (Merriam, 2009). Based on Merriam’s theory, a case study can be considered appropriate as a research method for the performance evaluation of national R&D projects and the improvement of the budgeting system. As a matter to be noted when conducting a case study, first, the researcher should check whether the subject of the study is suitable as a “case.” Second, researchers should try to find research problems inherent in the case. Third, researchers should focus all of their research on understanding a particular case. Fourth, researchers should intentionally pay attention to how the various contexts surrounding the case affect the activity and function of the case. Finally, it is important for the researcher to give a detailed description of the case to be studied (Lee, 2020). Based on the characteristics of these case studies, the following studies were conducted to derive improvements through case comparison between ROK, the U.S. and Japan. First, the current status of the performance evaluation and budgeting system of national R&D projects in ROK, which are carried out based on the Framework Act on Science and Technology, is analyzed. Then, this study would like to compare and review the differences through data analysis on the performance evaluation and budgeting systems of the U.S. and Japan. Second, based on comparative analysis through previous studies and global data analysis, this study intends to prepare a plan to improve the performance evaluation and budgeting system of the national R&D project in ROK.

4. Current Status of Performance Evaluation

4.1. Current Status of Performance Evaluation in the Republic of Korea

The performance evaluation of national R&D projects in ROK has been establishing a basic plan for implementing national R&D performance evaluation every five years since 2006. This basic plan is applied to the relevant systems and evaluations of R&D activities in the science and technology field conducted by the government. The evaluation types are classified into three evaluations: projects, assignments, and research institutes. In addition, ROK's national R&D projects can be divided into the 1980s, when the assignment level was evaluated for selecting a principal investigator, the 1990s, when the project level was evaluated from a comprehensive perspective, and the 2000s, when individual laws were enacted and implemented for R&D performance evaluation. The difference in the performance evaluation items of national R&D projects from the past performance evaluation was first, in the case of project evaluation, the focus of the evaluation was changed to the aspect of project management. Accordingly, the project evaluation focuses on the achievement of the preset goals and the excellence of the achieved results. In the case of the evaluation grade, it was previously five levels, but starting from 2021, it was simplified to three levels: excellent, ordinary, and insufficient. Second, the final evaluation of assignments evaluation is evaluated by the achievement of R&D goals and technical ripple effects. In addition, the level evaluation of the assignment evaluation is made by the excellence of the performance created in the previous levels and the validity of the following level research plan. The evaluation grade was previously different depending on research and management institutions, but since the implementation of the National R&D Innovation Act in 2021, the standard guidelines set by the Minister of Science and ICT have been followed.

4.2. Current Status of Performance Evaluation (the U.S., etc.)

In the U.S., the Government Performance Results Act (GPRA) was enacted in 1993, and to reinforce it, the Program Assessment Rating Tool (PART), a means of measuring performance in the category of GPRA in 2002, was applied. However, after the application of PART, problems were drawn in the evaluation method, abolished in 2009, and revised GPRA Modernization Act (GPRAMA), a new performance management system that revised the GPRA in 2010. The GPRAMA system considers consistency between the president's state affairs and the ministry's priorities, dealing with the promotion of the ministry's efforts to improve the performance of financial projects. The U.S. project, assignment, and institutional evaluation guidelines are established and evaluated by the

department that carried out the project. The National Science Foundation (NSF) and the Department of Energy (DOE) are the departments that perform R&D the most and conduct an evaluation using peer reviews for all assignments and projects included in Office/Division every two to four years without separately classifying assignment evaluation and project evaluation. Japan's national R&D project performance evaluation system is established based on the 「Overall Guidelines」 established every five years. These 「Overall Guidelines」 are high-level evaluation guidelines for all R&D projects carried out on the national budget based on the Basic Plan for Science and Technology. R&D corporations, ministries, etc., operate their own R&D evaluation guidelines based on 「Overall Guidelines」, and major R&D projects directly conduct a higher evaluation. As of 2019, Japan's national R&D expenditure was about 46.9 trillion won, accounting for the largest of them by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). In order to promote innovation creation, three revisions were introduced based on the 5th Basic Plan for Science and Technology (2016-2020), reducing the burden of R&D evaluation and promoting R&D that values novelty and social and economic impact. The R&D evaluation under the jurisdiction of MEXT shall be conducted to link the performance, operation improvement, plan review, etc., according to the evaluation target. R&D program evaluation is conducted for the purpose of determining the appropriateness of R&D performance and improving the quality. Through this evaluation, the direction of improvement of the R&D program is reviewed, and implications for selecting and establishing the next R&D program are derived. The big difference between the performance evaluation system in ROK and the U.S. is the presence or absence of a department in charge of science and technology. The U.S. has a decentralized system in which diversified technology policies are promoted by federal ministries in charge of their own administrative duties. In addition, the U.S. has a unified evaluation system under GPRAMA, but the ROK stipulates individual laws such as the Framework Act on Science and Technology and the Act on Performance Evaluation and Performance Management of National R&D Projects. In the case of ROK, it has an evaluation system similar to Japan's detailed evaluation guidelines, and it is characterized by having a high-level evaluation centered on MSIT and the Ministry of Science and Technology Innovation rather than self-evaluation. The self-evaluation results of the project have been simplified from the previous five levels to three levels (excellent, ordinary, and insufficient) from 2021, and these evaluation results are being used for budgeting and planning new projects. The following main points could be confirmed through a comparative analysis of performance evaluation cases by country. The performance evaluation system of the national R&D project in ROK lacks a connection between the results of

the project and assignment evaluation. In reality, research sites that are busy with short-term, quantitative results are also necessary to be solved. On the other hand, the U.S. and Japan support performance evaluation so that innovative research results can be derived through long-term large research projects rather than short-term results through system flexibility. Therefore, efforts to ensure consistency and efficiency of the results of the national R&D project performance evaluation system in ROK will be needed. Since ROK's current quantitative evaluation system may hinder the main purpose of national R&D projects, it is necessary to improve the evaluation system that can secure long-term development plans for national R&D projects in consideration of the main characteristics of each research field.

5. Current State of Budgeting

5.1 Current State of Budgeting in the Republic of Korea

The national R&D project of the ROK is characterized by difficulty in understanding the existing general budget theory. The purpose of the national R&D project is to develop basic source technology and apply them in the intermediate stage rather than technology development for practical use. Therefore, it is difficult to produce the results of the project in a short period of time compared to the national budget input. The budget for national R&D projects is widely reflected and implemented in basic, applied, and practical research.

In addition, the budget is used by a number of ministries based on financial resources made up of general, special, and fund accounting. Technological innovation in the 1980s, which was the beginning of the national R&D project of ROK, is considered to play a major role in economic growth. Budget investment in science and technology, the basis of national competitiveness, is continuously increasing. The budgeting system for national R&D projects in the ROK is an activity that seeks balance and enhances efficiency by providing consistent standards within the organization. The budgeting system of national R&D projects has been developed in close connection with the transition process of the comprehensive adjustment system according to the diversity of character. The comprehensive adjustment system of budgeting for national R&D projects in the ROK can be seen as a system that has been promoted and developed according to the characteristics of the country (Lee In-il, 2003). When the scope of national R&D projects increases, such as in advanced countries like the U.S., efforts to secure resources for efficient adjustment including various investment fields are needed. Few countries would have a comprehensive coordination system like ROK.

5.2 Current Status of Budgeting (the U.S., etc.)

In the U.S., science and technology policies are diversified by federal ministries that carry out their own administrative tasks of science and technology without a dedicated department at the federal government level. Coordination of these science and technology policies takes place in Congress and the White House. In addition, institutional research and management are distributed and conducted based on the main tasks of the state. Budget decisions in the U.S. are handled in the form of law, and the authority to submit bills is held by Congress. The White House Office of Science and Technology (OSTP) works closely with the White House Office of Management and Budget (OMB) and R&D prioritization, which oversees the president's science and technology assistant and overall matters about the president's budget work. "The administration establishes the guidelines for budgeting by referring to the federal budget plan and distributes them to the ministries, adjusts the budget submitted by the ministries and delivers them to the Congress (Korea Institute of Science & Technology Evaluation and Planning (KISTEP), 2020)." The president is responsible for the national budget, annually prepares an estimate of revenue and expenditure, and submits it to the Congress (Budget Accounting Act, 1921). "The OMB and the OSTP present guidelines for the presidential budget for research and development next year to administrative ministries and agencies. After that, each ministry prepares a budget request in accordance with the guidelines and submits it to the OMB (KISTEP, 2020)." "Finally, the OMB will review the ministry's budget request, prepare the president's budget (draft) and submit it to Congress in early February (KISTEP, 2020)." Japan's budget is a competitive funding system, and the fiscal year is from April 1 to March 31 of the following year. The timing of the R&D budget has been advanced from June to March to overcome national difficulties and sustainable growth since 2011. In addition, an advanced and systematic priority determination method was used to improve the budgeting and adjustment process. The new budgeting process aims at regularizing the budget to enable timely execution; secondly, transparency through public discussion and opinion of the budget; thirdly, focusing on the concentration of capabilities of major tasks to be solved by the government; and finally, efficiency to minimize overlap between ministries. Japan's budget allocation has a top-down hierarchical structure centered on the Council for Science, Technology and Innovation (CSTI), such as the R&D project evaluation system. These top-down budget policies encourage deregulation and tax burden on research activities to encourage private research institutes to invest in R&D, while encouraging linkage and cooperation in the performance of tasks between ministries such as MEXT and the Ministry of Economy, Trade and Industry (METI). Through a comparative analysis of the budgeting systems of the U.S. and Japan, it was confirmed that the connection between the top policies of national R&D projects and the budgeting of

government R&D projects was insufficient in ROK. In order to improve this, it is necessary to strengthen the function of PACST as the best decision-making organization in science and technology policy as a way to establish a connection with the basic science and technology plan. The budgeting system for each country differs in detail depending on cultural and historical matters. However, in common, close cooperation between ministries and related agencies is being conducted for the efficient allocation, coordination, and execution of the national R&D project budget.

6. Conclusions and Implications

6.1 Conclusions

Based on comparative analysis through case studies, measures to improve the performance evaluation and budgeting system in ROK were prepared. The current status of the national R&D project performance evaluation and budgeting system by country is summarized as shown in <Table 4>.

Table 4: Performance Evaluation and Budgeting System of National R&D Projects in the Republic of Korea, the United States, and Japan

	The Republic of Korea	The United States	Japan
Performance Evaluation	<ul style="list-style-type: none"> -Application of the national R&D performance evaluation plan in a 5-year cycle to the relevant system and evaluation -A master plan for national R&D performance evaluation is formulated through deliberation by the National Science and Technology Advisory Council -The Basic Act on Science and Technology and the Act on Performance Evaluation and Performance Management of National Research and Development Projects, etc., shall be prescribed by individual Acts -Higher Evaluation of the Ministry of Science and ICT's Innovation Headquarters and Self-Evaluation System of the Ministry of Science and ICT 	<ul style="list-style-type: none"> -Based on the Performance Management System of the Government Performance Results Act (GPRAMA) 2010 -Evaluation guidelines are established and evaluated by ministries that carry out projects in a decentralized system where diversified technology policies are implemented -Performing task and project evaluation through peer evaluation, which is a qualitative evaluation, based on independent department evaluation guidelines 	<ul style="list-style-type: none"> Operation of its own R&D evaluation guidelines based on the general guidelines for national R&D evaluation every five years based on the basic science and technology plan -Overall guidelines for national R&D evaluation are formulated by the General Science and Technology Innovation Council -A top-down evaluation system that follows the order of the state → ministries → research support institutes → research institutes
Budgeting System	<ul style="list-style-type: none"> -Budget preparation through cooperation between the Ministry of Strategy and Finance and the Ministry of Science and ICT -Budgeting through the preliminary decision of the special committee in the form of a budget 	<ul style="list-style-type: none"> -The administration establishes guidelines for budgeting by referring to the federal budget plan -Each department submits a budget request to the Ministry of Management and Budget (OMB) in accordance with the budget (draft) guidelines -Budgeting through a preliminary decision of the Standing Committee in the form of an appropriation law 	<ul style="list-style-type: none"> -Top-down hierarchical structure centered on the Innovation Conference of Science and Technology, such as R&D project evaluation system -As a competitive funding system, it has a budgeting procedure aimed at regularization, transparency, focus, and efficiency

In ROK, MSIT and MOEF are in charge of performance evaluation and budgeting through deliberation by PACST. This is similar to the system conducted through CSTI, centering on Japan's MEXT. On the other hand, in the U.S., science and technology policies are being diversified by federal ministries that independently perform administrative tasks of science and technology without a dedicated department at the federal level.

Through this study, a plan to improve the performance evaluation and budgeting system of the national R&D project in ROK was derived. In the case of performance evaluation, first, the reality of the research site is that the performance evaluation system is urgent in the short term, quantitative, and results. As an improvement plan, it is necessary to enlarge and prolong national R&D projects, and a plan to introduce a performance evaluation system by classifying categories for this can be considered. Second, there is a lack of linkage between the results of national R&D projects and assignments evaluation. Therefore, efforts to secure consistency and efficiency of the results of the national R&D project performance evaluation system of ROK will be needed. Third, the performance evaluation system of the quantitative evaluation method of ROK may interfere with the main purpose of the national R&D project. Therefore, it is necessary to improve an efficient evaluation system that can secure long-term development plans for national R&D projects. Active use of peer evaluation, one of the qualitative evaluations in the U.S., could be a solution. In addition, for the long-term development of national R&D projects, it will be necessary to revise the provisions related to science and technology of Chapter 9 of the Constitution of ROK. Currently, the Constitution stipulates that "science and technology must go along with economic development." This was an old perspective from the 1960s to the 1970s when it was an economically developing country, so science and technology and economic development should be revised separately. Finally, the linkage between the upper policy and the budgeting of the government's R&D project is insufficient. Therefore, it will be necessary to strengthen the function of PACST as the best decision-making organization in science and technology policy for connection with the basic science and technology plan. The Moon Jae Inn government re-launched PACST by combining advisory and deliberation functions, divided into the National Science and Technology Advisory Council and the National Science and Technology Review Council. However, strengthening its function as the best decision-making organization in science and technology policy is insufficient. As a result, it can be summarized as shown in <Table 5> as a proposal to improve the performance evaluation and budgeting system for national R&D projects.

Table 5: A Proposal for the Improvement of the National R&D Project Performance Evaluation and Budgeting System

Category	Current Situation	Improvement plan
Performance Evaluation	A short-term, strategic, and productive research site of the performance evaluation system	Promotion of large-scale and prolonged national R&D projects (introduction of performance evaluation system by category)
	Administrative burden arising from the individual performance of national R&D projects and project evaluation. The insufficient linkage between project evaluation results and task evaluation results	Efforts should be made to ensure consistency and efficiency of the results of the performance evaluation system
	Interference with the main purpose of national R&D projects based on the performance evaluation focused on quantitative evaluation. Lack of Long-term Development Plan for National R&D Projects	Introduction of Qualitative Evaluation Methods such as Peer Evaluation in the United States as Complementation of the Political Evaluation Method. The need to revise Article 127 of Chapter 9 of the Constitution to secure long-term development measures for national R&D projects (separation of science and technology and economic development)
Budgeting System	The insufficient linkage between high-level policies and budgeting for government R&D projects	Strengthening the functions of the National Science and Technology Advisory Council as the best decision-making body for science and technology policy

6.2 Implications

In ROK, performance evaluation has been mainly conducted through quantitative evaluation rather than qualitative evaluation. However, the evaluation method neglecting qualitative evaluation is a little possible to evaluate fragmentary performance results, but there is a limit to the evaluation of achieving the final R&D goal. The importance of qualitative evaluation is recognized, but the presentation of directions for more efficient and systematic qualitative evaluation measures is insufficient. Therefore, it will be necessary to prepare an effective system plan for the qualitative evaluation method. In this regard, it could be a plan to more actively utilize peer evaluation, one of the qualitative evaluations in the U.S. NSF and DOE of the U.S. conduct evaluations

as peer evaluations, which are qualitative evaluations, when evaluating projects and tasks. This peer evaluation is recognized and conducted as an objective and complementary evaluation through the objective evaluation of colleagues whether the project continues. ROK has also set a policy direction as a matter for strengthening qualitative evaluation, which is the basic direction of the fourth basic plan in 2021. For the long-term development of national R&D projects, it will be necessary to revise the provisions related to science and technology of Chapter 9 of the Constitution of ROK (i.e., ① The State shall endeavor to develop the national economy through innovation in science and technology and the development of information and human resources.). The provisions of the Constitution on Science Policy first appeared in the ‘Economy’ chapter of the 3rd Republican Constitution of ROK (announced 1962; enforced 1963). Since then, each constitutional amendment has changed a little, but a large system has been maintained.

The purpose of the national R&D project is to develop basic source technology and apply research in the intermediate stage rather than the development of technology for practical use. National R&D projects, such as basic research, tend to stop support from the state compared to R&D projects at other commercialization stages. This means that the provision that science and technology should strive for economic development has an effect on whether or not the national R&D project continues. Therefore, it is necessary to secure long-term development plans for national R&D projects, which are the basic R&D stages. In this regard, according to Park Geun-tae of the Korean economy in 2018, the science and technology community argued that “The current constitution excludes basic research and new knowledge creation,” and “It is necessary to stipulate that the state should strive for the development of science and technology.” As a result, since economic development is not related to the mid- to long-term performance of national R&D projects, Article 127 (1) of Chapter 9 of the Constitution should be revised. In this regard, in 2017, the Science and Technology Network, an organization of scientists and technicians, submitted a request for constitutional amendment through the Constitutional Amendment TF within the organization. According to Oh Cheol-woo of Science On in 2017, these opinions were submitted to the Economic and Financial Division of the Special Committee on Constitutional Amendment, suggesting that it is appropriate to delete Article 127 (1) of the Constitution and establish a clause in the “Chapter 1 General Lecture”, but were not submitted to the plenary session of the National Assembly. Accordingly, additional efforts by the science and technology community will be needed to deviate from the “constitutional” standard of the old perspective during the 1960s and 1970s in economic development countries. A constitutional amendment can only be initiated when public support and interest are reflected. To this end, in the science and

technology world, it will be necessary to prepare a logical basis for the existing constitutional provisions that hinder the sustainability of R&D projects and measures for policy matters.

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