

Designing an Integrated Funding Management System for National R&D Project

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Abstract. *As science and technology developed, people in modern society have never stopped stepping forward. Showing rapid increase in social growth and Research and Development (R&D) funding, South Korea have proved that they are also in the middle of this trend. There are countless projects that investors need to know how and where their funds are used. Developers from diverse fields have developed different types of management systems to help monitor and manage their projects. However, the systems are separated from the banking systems, which are in charge of transacting funds. As a result, there have been misuses related to the R&D funding. Realizing the seriousness of those problems, integrated project management systems appeared. The purpose of this paper is to analyze the real issues of managing R&D funding in the existing project management systems and introduce the architecture of the integrated systems.*

Keywords: R&D, Real Time Cash Management, Cash Management Systems, Research Management, Project Management

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1. Introduction

The research and development projects supported by the government commonly involve many stakeholders, including government ministries and agencies, management organizations, research institutions, financial institutions, corporations, etc. [7]. Even though the budget for national research and development projects is now controlled with IT technologies, any challenges still remain.

First, while financial institutions have made efforts to improve the budget management process and to provide support by developing the necessary IT technologies for its administration, full transparency has not yet been secured in the management and control of the budget for national research and development projects. Indeed, many cases of abuse or misuse of research funds have been reported, including demands for the return of parts of the labor cost in cash, overstatements or false reports of research expenses, etc.

Second, the workload related to the control of budgets for national research and development of projects have been on the rise. While the number of projects has been increasing by 1,000 cases on average per year, the workforce involved in budget

control has seen a steady decline [3]. Under these circumstances, problems such as delays in budget allocation have merged due to staffs' growing workloads, causing challenges in the implementation of the projects.

Third, the budget control Process for national research and development projects is becoming more complicated. The convergence of diverse industries and sectors in the field of research and development requires the involvement of various government ministries and agencies which need to share the results of the projects as well as the responsibility for their management. This complicated process or project fund management is one of the major challenges that need to be resolved in order to guarantee the efficient implementation of national research and development projects.

In order to deal with these challenges, efforts have been made to computerize the intermediate stages of the research and development project management processes, including the development of a project management system for the control of research expenses and a credit card settlement system for their use. [3, 4, 6] However, these systems are not connected to one another and use separate databases. No integrated system is currently available for consistent management of the overall process from budget planning to budget execution. Due to the many related challenges, connectivity between the credit card system of the financial sector and the fiscal management system of the government has not yet been pursued.

This study analyzed the problems related to the management of national research and development project funds and developed a system for real-time-based monitoring and management by connecting various systems related to national research and development projects. The system developed by this study was called the Real-time Cash Management System (RCMS). The system links the fund management processes of different organizations and institutions, and is capable of monitoring the flow of the funds on a real-time basis.

This system is currently being used on a trial basis for the management of national research and development projects. Many of the existing problems related to the management of funds for research and development projects have been resolved through the application of this system. The RCMS has simplified the budget administration process for national research and development projects, and enabled real-time monitoring. Furthermore, it has also facilitated the integration of the system interfaces of relevant organizations and institutions through the implementation of a common library.

1.1 Analysis of Current Conditions

The management of funds is the process of improving financial statuses by appropriately planning and responding to the need for expenditures through the control of cash flows and by investing the surplus funds which are temporarily generated [5, 6]. However, there is a significant difference in the perspectives of private corporations and the government regarding the purpose of fund management.

From a private corporation perspective, the purpose of fund management is to maximize corporate values and profits – the main goals of corporate management – by placing the emphasis on payment management, receipt management, liquidity management, fund analysis, fund planning, and fund operation, in order to accumulate more surplus funds [5, 7]. For the government, on the other hands, the purpose is to expand public revenue. This is realized through maximization of the funds by enhancing the efficiency of the cash-collection process, applying proper control over the cash disbursement process, ensuring the stability of the possessed funds, securing the liquidity to provide an appropriate response to the need for cash disbursement, and investing the surplus funds which are generated by making use of the times gaps between income and expenditure [3, 4]

The Korean CMS system has been built to provide fund management services to corporations only. Corporate fund management systems allow for real-time management of the payments and receipts of corporate funds, based on a financial system linked to banks' Internet banking systems.

1.1.1 Current System for Management of National Research and Development Projects

The management of funds for national research and development projects is currently achieved by the government by allocating funds to each field following deliberation by the National Assembly. After conducting budget planning in consideration of the proposed projects in each field, the government releases the allocated budget to an agency in charge of managing the funds for national research and development projects. The R&D management agency entrusted with the funds for research and development projects from government ministries and agencies designate research-executing organizations to perform the necessary tasks

for each project and to operate the funds. The research executing organization that has been designated is paid the necessary funds as a lump sum from the management agency and employs the research funds according to its project plans. Following the completion of the project period, the research executing organization makes a report on the detailed use of the funds to the management agency.

1.2 Problems of Current Management System of National R&D projects and Solutions

To date, three methods have been applied to improve the management of national research and development projects. The following is a description of each of these methods and the problems that arise from them.

1.2.1 Funds Use Report

A Funds Use Report is submitted on an annual basis to cover the period from the start to the end of a project. Based on the concept of 'use first and report later', this process aims to uncover any abuse or misuse of research funds by reviewing, comparing, and confirming the details of the fund use, bank statements, and the appropriateness of the level of expenses for each project.

Although this post verification method has been traditionally applied, it presents some limitations. As the research executing organization submits its report after completion of the project, it is not possible to monitor the flow of the funds on a realtime basis. Moreover, as the verification process depends on the copies of the documentary evidence submitted by the research executing organization, it is difficult to review and confirm the authenticity or duplicity of the documents.

1.2.2 Use of Credit Cards for Research Expenses

The credit card system for research expenses allows the researchers participating in a national R&D project to charge their research expenses to a credit card. This method requires researchers to enter the details of their use of the research funds into a comprehensive computerized system designed for the management of public research funds. It aims to support the management of the funds for research and development projects supported by the government in a comprehensive manner [8].

The merits of this method include the prevention of false or repeated submission of documentary evidence by checking credit card use on a real-time basis, and real-time monitoring of the use of research funds. However, there are limitations that it is not realistically possible for a research executing organization to process all its research expenses by credit card only. Despite the government and R&D management agencies' efforts to encourage the use of credit cards, only 3 to 17 percent of research expenses are paid by credit card, the rest being exchanged in cash. This method is therefore not sufficient to monitor the overall use of research funds and to secure transparency.

1.2.3 Monitoring of Research Expense Account

A research expense account monitoring method was temporarily implemented in 2008. Based on the development of electronic financial transaction systems, this method allowed R&D management agencies to access the research expense accounts of research executing organizations in order to conduct real-time monitoring. The monitoring was performed by reviewing the transaction details provided by banks as well as the credit card use details provided by credit card companies. This method presented an advantage in that it enabled the inspection of every fund transfer, overcoming the shortcomings of both the Fund Use Report and credit card use methods. However, this method has now been abolished due to the inconvenience of having to obtain authorizations to monitor accounts in compliance with the Real-Name Financial Transaction, as well as to follow the advice of the Financial Supervisory System to stop the operation of the monitoring system in cases where it is not possible to acquire the agreement of the account holder regarding the provision of transfer details.

1.3 Analysis of Problems of Current National R&D Project Fund Management Process

The current process for the management of national research and development project funds involves two parts. As shown in Figure 1, first part involves the transfer of the funds from the government to a research executing organization through the R&D management agency. The second constitutes the use of the funds by the research executing organization for implementation of the given project. In step 1, the fund use can be easily controlled by approval and transfer. The bank account used by the R&D management agency is operated openly – according to the principle of publicness –, and the process of approval, execution and transfer in relation to the use of the account is implemented on a lump sum basis. Therefore, the management of the bank statements for the account can be achieved in a transparent way.

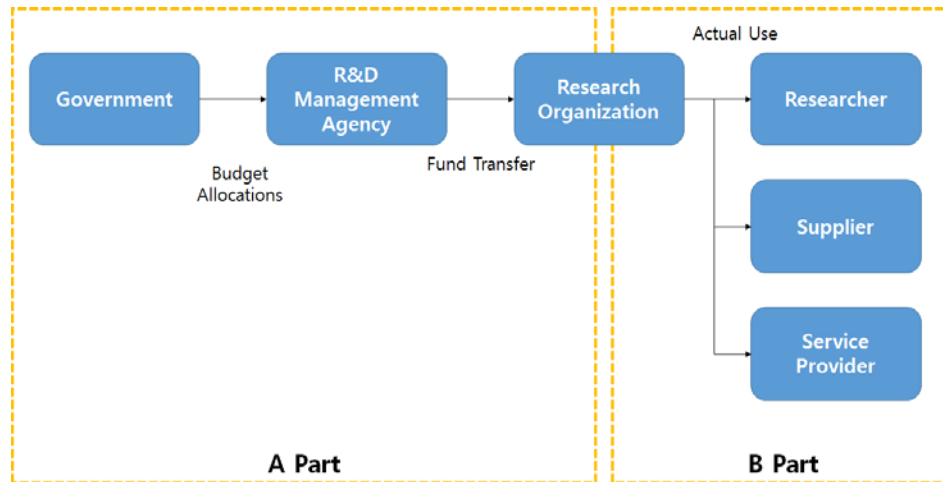


Figure 1. Government R&D Project Management Process AS-IS

Once the funds have been paid to the research executing organization, the problems related to the management of the research funds emerge. The R&D management agency cannot manage the flow of the funds after payment has been made to the research executing organization.

A research that organization executes is an independent corporate body and can operate the research funds provided as a lump sum by the R&D management agency through its own budget control system. Once the research funds have been paid to the bank account submitted by the research executing organization as the project expense account at the time of agreement with the R&D management agency, these research funds are owned by the research executing organization. Therefore, from that point on, the research can use the funds freely according to its own internal approval system.

The R&D management agency can only review whether the relevant research funds were used in accordance with the project plan after submission of the documentary evidence together with the Fund Use Report by the research executing organization. Furthermore, when the credit card method is applied, the R&D management agency can only review part of the funds use.

2. Design and Implementation of RCMS

2.1. Requirements and Analysis for Implementation of RCMS

In order to identify and analyze the requirements for the efficient management of governmental research and development funds, interviews were conducted with the following groups: (1) three persons in charge of the management of public funds for public organizations, (2) three researchers affiliated with the research center of a school or corporation with experience of participating in public research and development projects, (3) three persons specialized in system development, including a planner and a developer. A total of four interviews were conducted. A meeting was held with each group to identify the requirements of each function, and the three groups were then assembled to review the requirements proposed by the different group and finalize the list of requirements. As a result, the following five requirements were identified.

2.1.1. Directness

The system should have a direct connection to the bank accounts of the research executing organizations in order to allow for transparent review of the actual use of the cash by the organizations. Integrity cannot be ensured when review depends on the data submitted a posteriori.

2.1.2. Immediacy (Traceability)

Even if a structure is built to check the cash flows in the bank account of a research executing organization within the range allowed by the Real-Name Financial Transaction Act, if a part of the funds provided by the R&D management agency is transferred to a different account through a separate transaction, it becomes difficult to ensure the complete transparency of the fund flows. Therefore, the fund flow, including the amount of funds paid by the R&D management agency, the amount of funds used by the research executing organization, and the amount received by the final payee, should be treated as one transaction.

In other words, each transfer of funds should include information covering the entire transaction from start to finish (i.e., from initial payment by the R&D management agency to receipt by the final payee) so as to prevent errors or distortions in the intermediate stages.

By ensuring immediacy this way, a logical ground is offered for monitoring the inflows and outflows from all accounts through the monitoring of an account held by the R&D management agency. Moreover, by application of this method, it becomes possible to monitor bank accounts under others' names (something that was previously restricted by the Real-Name Financial Transaction Act), and the traceability of the fund flows is ensured.

2.1.3. Continuity

Continuity can be understood based on the overall structural aspects of the government's R&D budgets. When directness and immediacy (traceability) are secured, public organizations' fund flows can be easily reviewed from budget planning to final execution.

While it is possible to monitor the process of provision of the government budget by the R&D management agency to the research executing organization using dBrain, the results of the use of the research funds by the research executing organization itself can only be reviewed afterwards, based on the report submitted by the research executing organization.

The RCMS aims to manage the overall fund flows from the R&D management agency to the research executing organization and to the point at which the research fund is finally spent, securing continuity by reviewing the full flow of the funds in the private sector, something that was not possible with dBrain. When continuity is secured this way, the use of governmental funds in the real economy of the private sector can be monitored. This process will also offer more realistic policy feedback.

2.1.4. Legitimacy

Real-time monitoring of the fund flows guarantees that a given transaction actually exists and can be reviewed, but it does not confirm that a relevant fund was used in an appropriate transaction. Therefore, for a more reliable and transparent management of funds, an environment where the use of funds and related evidence can be managed together on a real-time basis needs to be created.

There are two ways of proving legitimacy: issuance of a tax invoice, and payment by credit card. Therefore, it is necessary to implement a policy for confirmation of the legitimacy of the fund flows by providing objective evidential materials (e.g. an electronic tax invoice and details on approval of the credit card use) on a real-time basis when there is a transfer of funds.

When the fund flows and related evidential materials are managed at the same time by the system, the use of a single evidential material for multiple cases can be prevented. In addition, this suppresses the need for the fund user to submit documentary evidence separately, creating a mutual benefit.

2.1.5. Generality

The application of the system could pose many challenges if the requirements described above are applied to particular financial institutions only. Most research executing organizations have main banks offering diverse financial IT services. Therefore, if research executing organizations' choice of financial institution is restricted as a result of the fund management method applied by the government, many issues are likely to arise. In fact, this problem was evidenced when the policy of using a credit card for research expenses was applied, as researchers were required to use credit cards issued by a particular financial institution. Therefore, it is important to allow researchers to choose their financial institution freely by allowing them to request payment whenever needed.

2.2. RCMS Architecture

As illustrated by Figure 2, the allocation of the governmental R&D funds is performed through a chain of transfers between three accounts, held by the R&D management agency (SA: Source Account), the research executing organization (PA: Pass Account), and the end beneficiaries (TA: Target Account), respectively. Under the existing management system, the R&D management agency cannot check the use of the research funds by the research executing organization on a real-time basis. The reason for this, as demonstrated in Figure 2 (A), is that once a research fund is provided as a lump sum to a research executing organization, under current applicable laws and regulations the R&D management agency is not allowed to review the details of the use of the research funds, as the research executing organization uses the funds from its own account (PA). The only

account that the R&D management agency can check is the SA account.

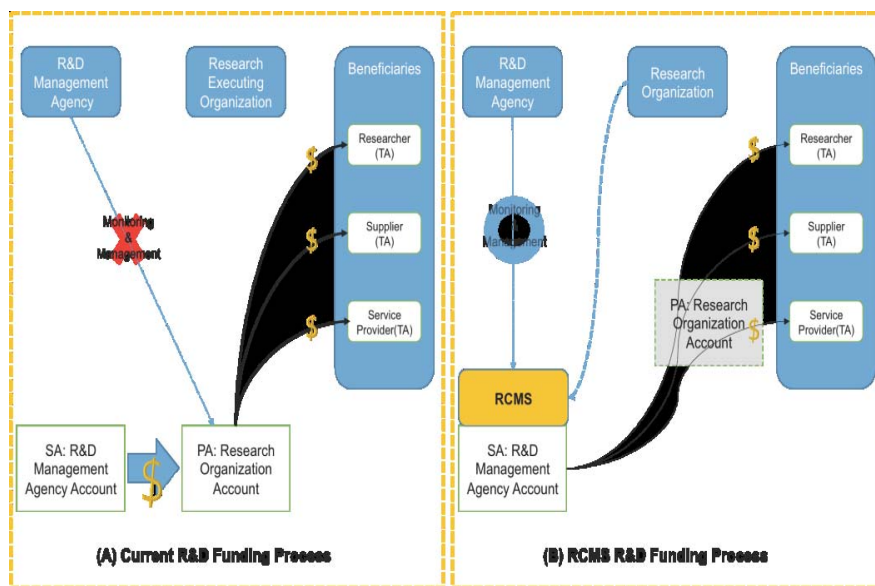


Figure 2. Before (A) and After (B) Real-time Cash Management System

This problem can be resolved by requiring the use of research funds to originate from the SA account, as shown in Figure 2 (B). In this scenario, the R&D management agency can check the account of a research executing organization (PA account) by checking its own account (SA account). The RCMS has been designed to enable real time integration of the transfers, as described above. When the system is applied, the role of the PA account is reduced to that of an account that the research fund simply passes through so that the research executing organization may use the relevant research fund. It no longer functions as an account for depositing and managing the research funds. Under this system, the R&D management agency can check the flow of the funds in and out of the PA account through the SA account, where the same flows can be observed. The conceptual architecture of the RCMS satisfies the above five requirements of directness, immediacy (traceability), continuity, legitimacy, and generality.

2.3. Implementation of RCMS

Figure 3 shows the implementation of the RCMS in accordance with the analysis of the requirements and necessary architecture. The RCMS offers various service systems for the real-time, clear management of research funds. These systems are linked to gateways providing connectivity with financial institutions, related organizations, management agencies, accounting departments, etc. Depending on their conditions and environments, given institutions or organizations can choose the Web or dedicated communication networks as their gateway.

2.3.1. Standard Library

As shown in Figure 4, the RCMS includes BCSs, which are common components offering services including inquiries into real-time based fund management, real-time based transfer, multiple transfers, etc. Besides, various Biz services have been built into the system to enable reduction of the transfer limit, password verification, transfer implementation, interest payment, inquiries, etc. The Biz services of the RCMS are mapped to each task within the framework. Combining standard library items forms each task. Each standard library item is linked to IDO and IMO for connectivity with the DB and banks. Based on this frame, organizations or institutions using the RCMS can make use of various services, including real-time based checking of fund flows at the bank, fund transfers, etc.

2.3.2. System Interface Integration

For system interface integration, the standard interface was defined at the framework level, and its adapter was built in to enable the processing and conversion of messages between heterogeneous systems. Diverse protocols such as TCP/IP, or SOAP were built into the standard adapter and were linked to the services of the RCMS through the channel interface within the framework. Figure 5 presents a conceptual diagram of the system.

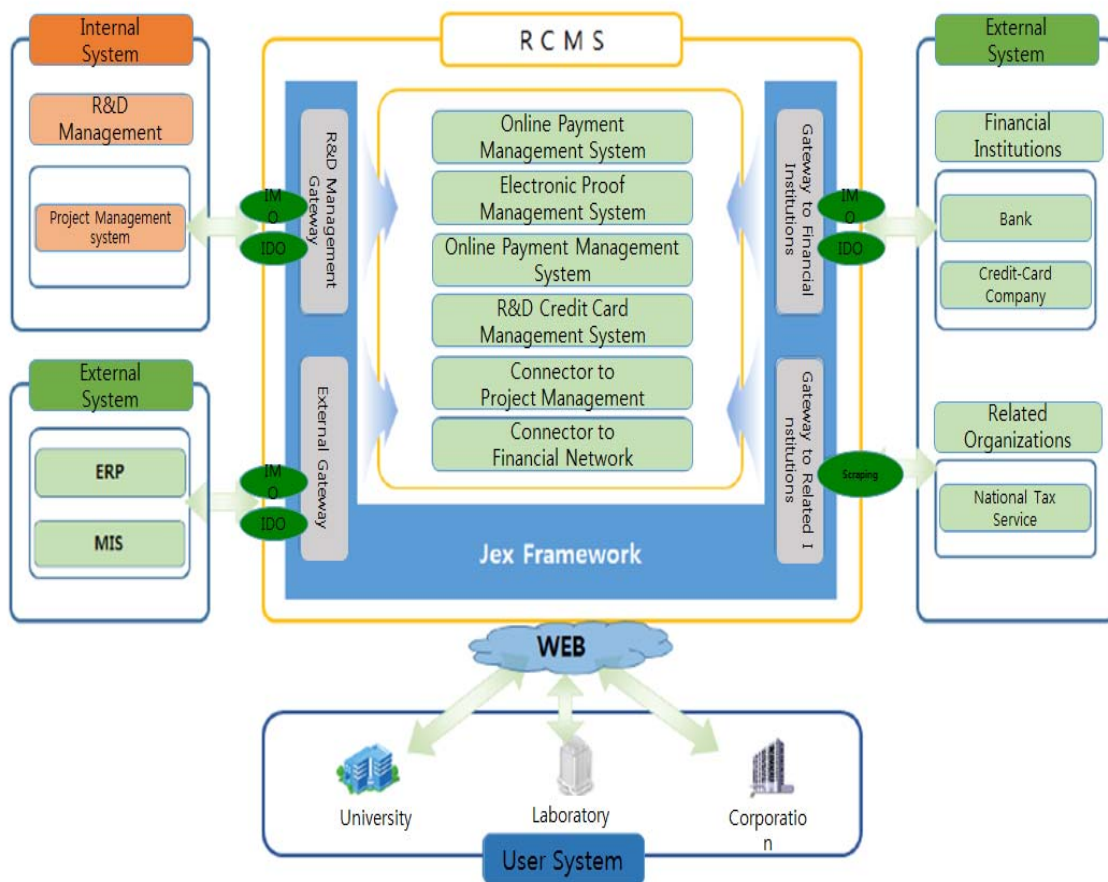


Figure 3. Real-time Cash flow Systems Architecture

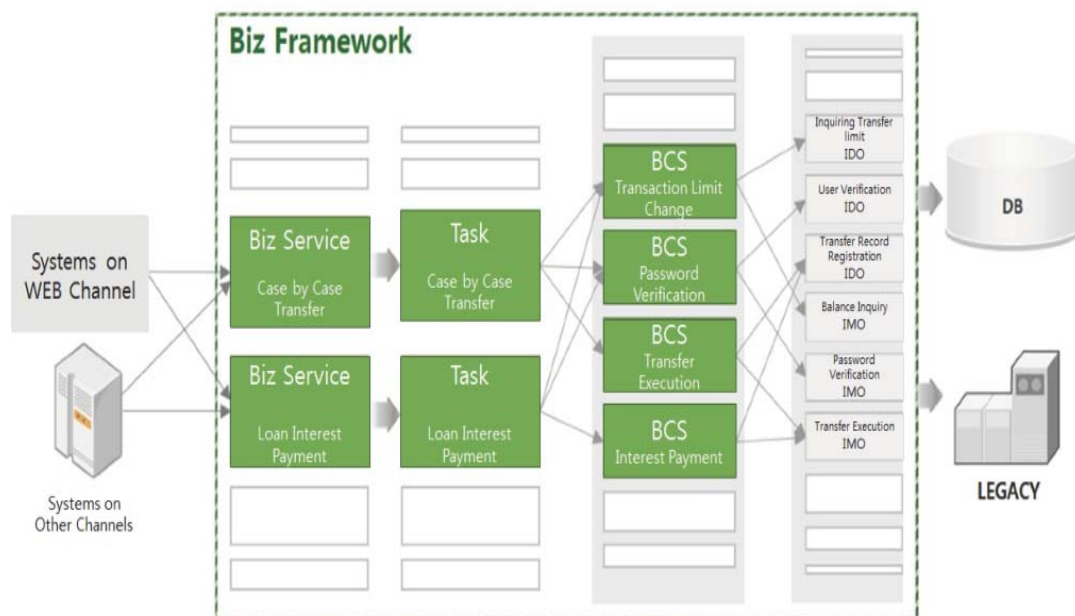


Figure 4. Real-time Cashflow Management System Standard Library

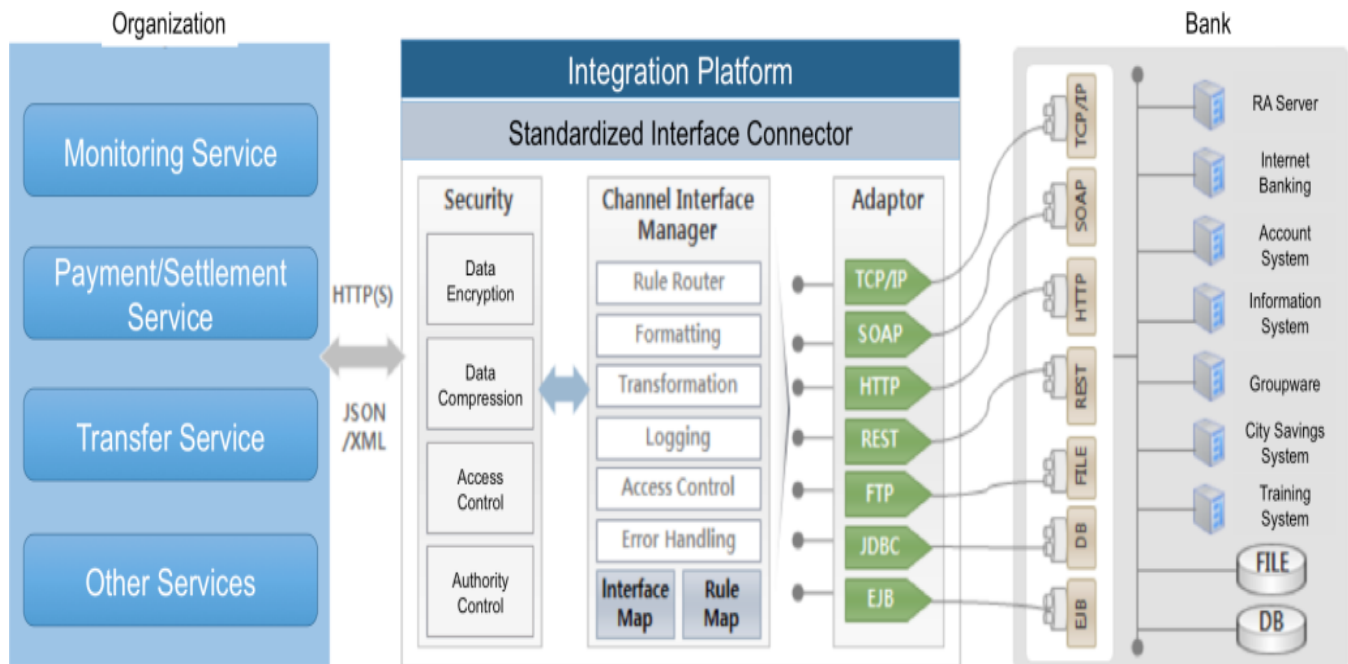


Figure 5. Real-time Cashflow Management System Interface Integration

2.3.3. API for Connectivity

For scalability, i.e. in order to be able to include more organizations and institutions in the future, various open APIs supporting connectivity were built in to enable a flexible and convenient response to the need for expansion of the services and registered organizations in the RCMS.

3. Analysis of Effects of RCMS Application

The World Bank evaluates the efforts for innovation and reform in each country based on the indexes of the aggregate amount-based fiscal goals, the efficient allocation and use of resources, the autonomy of administrative institutions, the responsibility of managers, etc. The qualitative efforts of countries to achieve these are quantified and evaluated [2, 6].

Globally, few systems for managing national research funds have been built, and direct comparison with other countries is therefore difficult. Previous studies that have examined the investment results of a national R&D project in relation to Internet banking or financial IT have analyzed the effects in terms of profitability enhancement based on cost reduction and profit improvement [1, 9]. Therefore, this study evaluated the effects of the application of the RCMS according to the following categories: transparency in the use of national research and development project funds, efficiency in the management of research funds, and convenience for users. A quantitative analysis was conducted for those criteria.

3.1. Qualitative Effects of Implementation of RCMS

The effects of the introduction of the RCMS can be evaluated based on the following categories: transparency in the use of national research and development project funds, efficiency in the management of research funds, and convenience for users.

First, as regards transparency, the use of research funds for inappropriate purposes can be prevented by blocking unauthorized lump-sum withdrawals of research funds through the application of a real-time payment system. Moreover, the system for managing evidential materials, which is connected to the National Tax Service and credit card companies, can help prevent the false or repeated report of evidential materials. Furthermore, as the system supports real-time registration and use, it is thought to have psychological effects in restricting the abuse or misuse of research funds by researchers. In fact, in a questionnaire surveying 765 users of the RCMS, about 62.4% of the respondents (79% in the case of small- and medium-sized enterprises) reported positively on the effects of the real-time based payment system in preventing the abuse or misuse of research funds.

With enhanced transparency in the use of research funds, the reliability of R&D projects can be strengthened, satisfying the public's right to know. If expanded to the control of national budgets, the application of the RCMS will help improve the transparency of the government's fiscal operations, and thereby enhance the national competitiveness of Korea.

Second, with respect to efficiency in the management of the research funds, the RCMS has simplified the research fund management process through the Web-based handling of payments and evidential materials. As the detailed use of the research funds is recorded on an individual transaction basis and can be checked whenever needed, the burden of site inspection to review suspected cases of abuse or misuse is reduced. In particular, as the whole process for research fund management can be conducted over the Internet, the offline-based management of billing information is also greatly reduced. On the part of system users, the burden of keeping evidential materials for a long time is decreased.

Third, in terms of convenience for the users, the latter can benefit from the systematic planning and payment of research funds based on a system which guides the payment of the funds and enables real-time inquiry into their detailed use. Using the RCMS, feedback is given every three months to research executing organizations on their use of research funds, helping to reduce the burden of processing the payment of adjusted amounts with respect to unauthorized uses in the future, and preventing inappropriate requests for, or payment of, research funds due to mistakes.

3.2. Quantitative Effects of Implementation of RCMS

The financial effects of the application of the RCMS were calculated for areas in which the qualitative effects could be quantified. Table 2 shows the qualitative performance of the RCMS application, which was analyzed by placing the main focus on the efficiency of the fund management rather than on the transparency or convenience.

'Interest redemption' means the interest earnings generated in the account of the R&D management agency as the method of research fund lump-sum payment was replaced with the RCMS. The interest earnings generated from government contributions go back to the state coffers. For example, when a one-trillion-won budget is executed based on this system, about 11.4 billion won of interest earnings will be returned to the government. Our estimation of the amount of interest earnings was made by applying an interest rate to the average remaining balance in an RCMS account so that the amount can vary according to the variations in the interest rates.

'Fund leakage prevention' means prevention of the failure to reconstitute the remaining balance due to bankruptcy, business closure, etc., which is more effectively avoided when the research funds are kept in the account of the R&D management agency. The calculation was made based on historical data on the loss of research funds due to bankruptcy, business closure, etc.

'Maximize R&D utility' designates the possibility of regenerating research funds based on the merits of the RCMS system, rather than the direct restitution of the funds. When the ratio of the amount of money for which approval was rejected and the account balance were compared before and after application of the RCMS, it was found that the ratio of the rejected amount of money decreased while the balance increased after application of the RCMS. This is thought to be due to the reduced ratio of payment disapproval in the RCMS environment, in which feedback can be offered during the use of the funds. The increase in the balance is also believed to result from a more careful use of the research funds in an environment in which requests for research funds use, payment and monitoring can be made on a real-time basis. The budget thus secured is returned to the state coffers and is included in the budget planning for the following year.

4. Conclusions and Future Research

The abuse or misuse of R&D research funds has emerged as an important challenge, and the RCMS has been built to provide a response to this problem. Once properly understood and applied, the RCMS may serve as the optimal option for managing not only research funds, but also governmental or corporations' budgets in a transparent and convenient manner.

In this study, the RCMS was implemented and applied to improve the process of national research fund management, and its effects were verified based on actual application cases. The application of the RCMS can be progressively expanded not only to the management of national R&D funds, but also to the general management of budgets by government ministries, agencies, organizations, etc. The scalability of the RCMS has been ensured through the use of standard libraries and APIs to enable the addition of new services and channels.

Section	Basis of Calculation	Economic Benefit Per One Trillion Won (KR)	Total Amount
Interest Redemption	1.14% Redemption of R&D Fund Interests	11.4 Billion Won	29.04 Billion Won
Fund leakage prevention	Remaining Balance Redemption (0.084%)	0.84 Billion Won	
	Fund at Bankruptcy (0.06%)	0.6 Billion Won	
Maximize R&D Utility	Decrease of Reimburse Rejection (0.33%)	3.3 Billion Won	
	Increase of Remaining Balance (1.29%)	12.9 Billion Won	

Table 1. Economic Impact Analysis

If the application of the RCMS is expanded in the future, it will help implement a consistent management system by developing a standard fund management process for governmental entities and corporations. It can also enhance the user convenience through the connection to existing accounting systems.

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