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Study of the Management for Successful R&D Projects Supported by Public Funds

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Abstract

There are various factors associated with success or failure of R&D projects, such as maturity of the technology, circumstances surrounding R&D systems within companies and environments for commercialization of R&D projects. For R&D projects supported by public funds in particular, it has been difficult to clarify what makes R&D projects successful, because such projects were caught in the idea that they must naturally succeed. What is really required in utilizing public funds for R&D projects, however, is ensuring the public funds should be used most effectively, by making R&D projects truly successful. To do so it is very useful to analyze past cases and identify success factors that can be easily followed.

In this study, surveys and interviews were conducted for past publicly supported projects, and success factors were extracted based on the circumstances of the projects by using statistical methods. It was confirmed that the quantitative results were quite consistent with the qualitative anticipation. After streamlining the success factors, further examination of each success factor was carried out for realizing proper management of projects supported by public funds.

Next, the guidelines for selection and process management for publicly supported projects while making the best use of these success factors were presented. That is, satisfying the success factors should be a requirement for public support from the start during the selection stage. However, in some cases it is desirable to adopt projects even though the success factors are not satisfied at the time of selection, when such projects are expected to provide extraordinary results in the future. In such cases, executing proper process management and leading projects in a manner that satisfies the success factors is indispensable.

1. Background and Purpose of the Research

The factors determining the success or failure of R&D projects are thought to be related to various parameters, including maturity of the technology, the circumstances surrounding R&D systems within companies and environments for commercialization. While the success factors of a project can be envisaged to some extent, the fact is the parameters that have been explicitly clarified are very limited[1]. Typically, examples of R&D failures are not readily exposed for all to see, yet amidst this limitation, new opportunities to clarify past problems from a management standpoint have continued to appear in the private sector[2]. At public institutions, on the other hand, conditions have made it difficult for examples that can be deemed failures to even officially exist[3]. The reason is thought to have been widespread existence of the attitude that projects had to succeed when publicly supported[4]. The *Consortium R&D Projects for Regional Revitalization*, a program of publicly solicited projects implemented in past years on public themes, is a valuable example in which success factors for projects that used public funds were analyzed. Based on this program, the following have been enumerated as factors that, excluding those unique to specific projects, will typically apply as matters required by a project to lead the effort to success[5].

- Project management aspects: The presence of a key person to manage the research; the setting of clear objectives
- R&D aspects: The establishment of themes with adequate consideration given to needs; a sufficiently formulated intellectual property strategy
- Marketing aspects: The participation of a key person from a marketing perspective on the research team

With such conditions as a premise, it would be worthwhile if easy-to-judge

success factors were elucidated, to ensure R&D projects based on the use of public funds attain success in the true sense of the word, and achieve more effective use of public funds. In this study, such success factors based on examples of specific systems are clarified, and they are used to suggest indicators to emphasize during the project selection and progress management processes when utilizing public funds in the future. We believe this approach to success factors can be applied for R&D project management at private sector entities as well.

2. Research Methodology

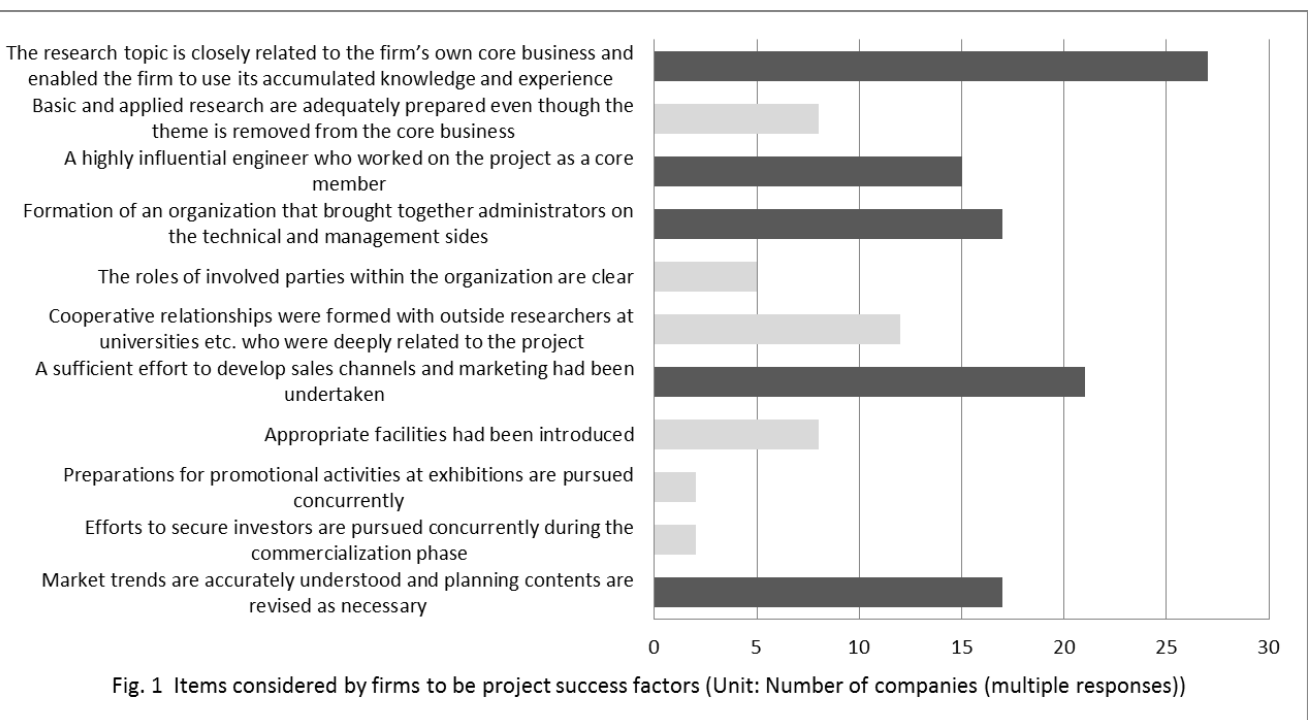
In the present study, our analysis of success factors focused on the system by which private sector firms use public funds to conduct R&D and contribute to society and the economy by putting the results of their research to practical use. Specifically, we looked at participating projects under the *Development Grant Program for Practical Application of Industrial Technology* that have been implemented by the New Energy and Industrial Technology Development Organization (NEDO), a public institution[6].

For the study, we implemented a questionnaire survey and conducted interviews concerning specific projects supported by this system. Based on this information, we took into account the successful and unsuccessful results of the supported projects themselves, and sought to analyze the success factors for a system that utilizes public funds and outlined management considerations for the use of public funds.

3. Selection and Analysis of Success Factors

The system reviewed in the present study is one in which NEDO, a public institution, selects projects it considers worthy of support from among project proposals based on the initiatives of private sector firms, and provides them with public support. In that sense, it is possible to view such success factors of R&D as simultaneously being those for public support as well as those at private sector companies. Here we have defined “success” as a company being able to record sales within three years after such R&D assistance has been completed (including when a company expects to report sales) , which is the expected result of this support system from the beginning.

We first implemented a questionnaire survey of 54 firms, which are all of the targeted firms for the survey, that had completed a grant project after conducting R&D with support under this system. From the results, we selected items the firms considered to be success factors, then conducted interviews at 28 of the companies and analyzed the success factors.



3-1 Selection of success factors

At firms that had completed their projects, we implemented a questionnaire survey concerning the factors that led to the success of their project or the factors that were insufficient and resulted in the project not achieving its goals. Figure 1 shows the results. The question items in the survey were each item in Figure 1, and the result for each item summarizes the number of firms that indicated they considered the item a success factor at the time of starting the project. Based on the results, the following items were clarified as the factors having the greatest importance from the perspective of the firms.

- The research topic was closely related to the firm's core business and enabled the firm to use its accumulated knowledge and experience
- A highly influential engineer who worked on the project as a core member
- Formation of an organization that brought together administrators on the technical and management sides
- A sufficient effort to develop sales channels and marketing had been undertaken
- Market trends were accurately understood and planning details were revised if necessary

Using the above survey results as a premise, we conducted interviews at 18 successful firms and 10 firms that did not have successful results and attempted to extract the project success factors. At this juncture, based on the indication that “in order to be manageable it must be visible,” we were mindful that for easy judgments, success factors should be specific rather than abstract[7].

Table 1 Survey of Conditions at Successful and Unsuccessful Firms, Based on Firm Interviews

	Successful firms							Unsuccessful firms							
	○	△	X	NA	Total	○: Pct.	X: Pct.	○	△	X	NA	Total	○: Pct.	X: Pct.	
Preceding research results	12	5	1	0	18	66.7%	5.6%	1	7	2	0	10	10.0%	20.0%	
Superiority based on owned patents and know-how, no reliance on other companies for core technologies	12	6	0	0	18	66.7%	0.0%	2	4	4	0	10	20.0%	40.0%	
Feasibility of achieving the technical development objective	5	13	0	0	18	27.8%	0.0%	0	7	3	0	10	0.0%	30.0%	
R&D organization	Presence of dedicated, full-time researchers	16	1	1	0	18	88.9%	5.6%	7	0	2	1	10	70.0%	20.0%
	Whether R&D is positioned within Company's proper targets; presence of a competent manager	10	8	0	0	18	55.6%	0.0%	0	8	2	0	10	0.0%	20.0%
	Participation by the operating division	14	2	2	0	18	77.8%	11.1%	3	0	7	0	10	30.0%	70.0%
	Existence of customers as evaluators	14	3	1	0	18	77.8%	5.6%	1	2	7	0	10	10.0%	70.0%
Clarity of the sales channels	16	2	0	0	18	88.9%	0.0%	2	7	1	0	10	20.0%	10.0%	
Reliability from a production aspect	13	5	0	0	18	72.2%	0.0%	5	3	1	1	10	50.0%	10.0%	
Certainty of market formation	12	6	0	0	18	66.7%	0.0%	0	10	0	0	10	0.0%	0.0%	
Verification of customers' needs	10	8	0	0	18	55.6%	0.0%	2	2	5	1	10	20.0%	50.0%	
Certainty of commercialization planning	Has a steady outlook	6	10	0	2	18	33.3%	0.0%	0	9	0	1	10	0.0%	0.0%
	Project period is appropriate	10	6	0	2	18	55.6%	0.0%	0	8	1	1	10	0.0%	10.0%

(Legend) ○: Pertinent; △: Generally pertinent, but not applicable to some aspects; X: Corresponding conditions not provided; NA: Cannot obtain information.

Next, based on the results of the questionnaire, we selected the items shown in Table 1 as those items that might be deemed to influence the success of a project. In the interviews, we asked the firms to indicate their response to each item in Table 1 by using a circle (○), triangle (△) or “X”. The meaning of each mark was

○: Pertinent;

△: Generally pertinent but not applicable to some aspects;

X : corresponding conditions not provided

Table 2 Results of χ^2 test on interview items and success or failure

Interview items		χ^2	
Preceding research results		8.372	**
Superiority based on owned patents and know-how, no reliance on other companies for core		10.080	***
Feasibility of achieving the technical development objective		8.182	**
R&D organization	Presence of dedicated, full-time researchers	2.087	
	Whether R&D is positioned within Company's proper targets; presence of a	10.578	***
	Participation by the operating division	10.464	***
	Existence of customers as evaluators	14.897	****
Clarity of the sales channels		13.481	****
Reliability from a production aspect		2.313	
Certainty of market formation		11.667	****
Verification of customers' needs		12.300	***
Certainty of commercialization	Has a steady outlook	4.441	**
	Project period is appropriate	10.119	***

Note: **p<0.05, ***p<0.01, ****p<0.001

Table 1 is a summary of the results. At this point we performed a chi-square test based on the results in Table 1. The result is shown in Table 2. Each item was thought to be a factor that might be deemed to influence the success of a project, and given the outcome shown in Table 2. Thus it can be supposed that the items have an effect

on the success of a project except “presence of a dedicated, full time researcher” and “reliability from a production aspect”.

While each item presented in the interviews was based on qualitative assumptions, given the results of the above analysis those items which, with several exceptions, influenced the success of the projects (referred to below as “the influencing items”), could also be quantitatively confirmed.

3-2 Analysis of the success factors

By grouping related items, we trimmed the influencing items discussed above to the following five success factors for R&D projects.

- The existence of R&D that preceded the project in question
- The clear position of the R&D theme as part of the company’s medium-term management plan and other efforts
- A close cooperative relationship with operating divisions
- A clear understanding of core customers
- The presence of a key researcher who continuously plays a key role as a full-time individual on the project

The specific conditions concerning these success factors, which were derived based on the results of the questionnaires and interviews, are discussed below, together with supplementary information obtained from the firms during the interviews.

(1) The existence of R&D that preceded the project

This item is derived from several of the interview items: “preceding research results,” “superiority based on owned patents and know-how” and “the feasibility of achieving the technical development objective.”

One consideration enumerated as a factor leading to a project’s success was having made progress in basic research on the subject theme and the clarification of principles to a certain extent, prior to efforts aimed at commercialization R&D. Another critical parameter is having obtained patents, based on the preceding R&D, that provide a foundation for commercialization. It is believed that in many situations the prospects for achievement of the technological development objectives are obtained through these steps.

On the other hand, setting a commercialization objective that is far from the results of the previous research has been cited as an instance when the benefits of preceding research cannot be used to maximum advantage. But this means such research ultimately has not really become preceding research at all.

Moreover, in situations where an important component of the preceding research depended on another company’s technology as well, the effect of the previous work diminishes in the sense the company’s own control becomes less effective. In addition, no positive results have been generated when the scale of the previous work was too small, or when there is too little connection between the preceding research and the subject theme.

(2) Position in the medium-term management plan and other efforts

This is another way of restating the item “Whether R&D is positioned within Company’s proper targets; presence of a competent manager”

How clearly the target R&D has been positioned within efforts such as the company's medium-term management plan has a significant influence on the success or failure of the project. According to the interviews, a position that demonstrates the research is an important project and a new business as a company means a company-wide system of cooperation, and remarkably elevates the importance of the theme at the firm. For the individuals implementing the R&D, such positioning is understood to mean "failure" is not acceptable. Especially at private sector firms, R&D is considered a failure if it does not result in sales and generate earnings. Consequently the research division will become more earnest.

Furthermore, the fact that R&D is positioned clearly within the company will produce results that improve its chances of success, such as a new organization being formed and the involvement of managers, other than the persons directly responsible for the research, who understand the project with an awareness of acting as a go-between with other management layers. Moreover, a powerful organization within the operating division as described in the following section becomes easier to achieve.

Because of reasons such as those described above, it is thought that over time, the tendency for managers to aspire to a "commitment (pledge)" will be heightened, and the probability of achieving an objective that has been set forth as a company will increase. Moreover, even if R&D is not clearly described in a medium-term plan or other material, the same effect is thought to be achieved if the position within the company, such as its recognition by top management, is clear. As a success factor, such positioning is explicitly manifest as the difference between success and failure.

(3) Cooperative relationship with the operating division

This item is related to the interview items “participation by the operating division” and “clarity of the sales channels.” During the commercialization phase, keeping considerations such as mass production and cost reductions in mind and maintaining close cooperation with the operating division are necessary because of the fact that the product image will have solidified to some extent. An operating division and profit center does not want to spend money on a project with little feasibility. Therefore the operating division’s display of interest can itself be seen as “insuring” the feasibility of the theme that will be the subject of the R&D. In addition, because the operating division also possesses information concerning users, markets and regulations, as well as knowledge of environmental-related constraints, close cooperation with the operating division has the effect of increasing a project’s feasibility.

Here, for firms that achieve success without the participation of the operating division, other factors are thought to offset the lack of operating division participation. Either an understanding of the details of customers’ requests based on a technology development road map for the sector where the pertinent R&D has been carried out, or customer-related information that was easily obtained through research results and existing product activities over long periods of time, has been enumerated. In any event, it can be said that circumstances that enable a company to have an outlook for commercialization with the participation of the operating division can be called a sufficient condition for project success.

(4) A clear understanding of core customers

A clear understanding of core customers can be related to many factors. Among

the interview items, it is related to “certainty of market formation,” “verification of customers’ needs,” “existence of customers as evaluators” and “certainty of commercialization planning.”

In the “certainty of market formation” sense, the point is whether the development objective has clarified differentiation with existing products, and whether the objective has sufficient strengths and those strengths are recognized by customers. In the “verification of customers’ needs” sense, it is clear that core customers are to some extent certain if the R&D theme is akin to their core business. In such situations, contact has already been made with the envisaged customers and the specifications have been clarified with them, and their cooperation in the research process has also been obtained, and by clarifying the objectives it is possible to proceed efficiently with the R&D. Specifically, when the “sales window” is limited by the capital equipment update period cycle, communications with customers makes it possible to attain well-timed understanding. Shortening the research period by narrowing down the product goals from a functional perspective through correction of over-specifications, for example, has also been cited. In the sense of “existence of customers as evaluators” commercial development feasibility declines under circumstances where no contact with the envisaged customers has been made and the ranking in the user’s evaluation is inferior to those of competing firms. Finally, because it leads to a precise judgment of the market and makes it less likely for discrepancies to occur between the development goals and the specs demanded by customers, the clarification with customers as described above is also linked to the “certainty of commercialization planning” and increases the probability that commercialization will proceed as planned. A solid grasp of customers’ needs can be called a critical characteristic for business success.

In cases where success had been achieved despite a lack of understanding of customers' needs, on the other hand, market cultivation was undertaken after the fact using the powers that are a large enterprise's strong points, or has been supplemented by a focus on providing products quickly rather than on addressing customers' needs. In cases that do not achieve success despite an understanding of customers' needs, the conditions involved either an obstacle to raw materials supply in recycling-related operations, or some problem that occurred during the principle clarification phase.

(5) Presence of dedicated researchers

One item that does not necessarily influence the success or failure of an R&D effort is "the presence of dedicated, full-time researchers." Nevertheless, this item was emphasized in the initial questionnaire survey and evaluation of other businesses[5], and we want to add it to the discussion.

Having dedicated, full time researchers can mean various things. One point that comes to mind is that when the research to be undertaken has a sufficient position within a firm, preceding research results tend to exist and, based on the research, progress has been made in securing positive results, including the accumulation of knowledge and patents. Moreover, because of their ability to gather information on the status of competing technologies and the possibilities for creating external networks, for example, such researchers also play a key role in setting the R&D trend. At many firms an R&D theme is transferred from the laboratory or other development division to the operating division when the firm begins nurturing the R&D effort, and in such situations it is typical for the researchers who have been involved up to that time to continue their research by some means such as reorganization.

In this research there were multiple examples where dedicated, full time

researchers have been assigned even at firm where R&D was not a success. Therefore although we might be unable to say whether this item has an effect on the success or failure of an R&D effort, we can say it has the characteristics of the necessary conditions needed to lead a project to success. Therefore it is true that the position of R&D internally or the presence of human resources who can cooperate with the effort for commercialization are important elements as noted in the preceding section, and citing the presence of dedicated, full time researchers as a necessary parameter for project success is considered appropriate.

Because small and medium-sized firms would form an organization with a limited number of researchers, however, it is not considered appropriate that they be required to support projects with dedicated researchers in the same manner as large enterprises as a premise for receiving public support.

By adding such considerations to the identified success factors as described above, these items can be positioned among the important factors that lead a project to success.

4. Application of the Success Factors to Public Funds

In the questionnaire survey sent to 54 companies as described above regarding projects to carry out R&D with the goal of pursuing commercialization by receiving public funds, we asked about the internal positioning of these projects. The results are shown in Figure 2. Glancing at the figure, we can see that we can direct our attention to the items with relatively high weights: “a sector peripheral to core business” and “development has (commercial) viability risks”.

That is, the outlook as a technology is to some degree established by the firm. But because any project involves uncertainties regarding its commercial feasibility, and offers poor prospects when it veers away from a company's core business, companies can be seen to adopt a stance of trying to implement their R&D after receiving a grant.

With regard to a project as a core business, technical issues for the project can be solved sufficiently in-house, where the project can be pursued with adequate forecasts, and existing sales channels and customer relationships can also be used for the business. For a project on the periphery of a core business, on the other hand, comprehensive in-house response that is a critical factor for the project's success cannot be achieved, and new sales channels must also be created and new customer relationships must be built. In other words, even if the technical issues are resolved, other commercialization risks remain until the project is developed into a business. Such an inclination is thought to be at work from the start as an intention to rely on public funds.

Nevertheless, according to the results of a chi-square test performed for the relationship between the success or failure and the internal positioning of a project for which a firm requests public funds shown in Figure 2. Whether a project is or is not a core business does not necessarily have an effect on the project's actual results in terms of success or failure. The reason for this is thought to be the fact that the boundaries of the "core" business are not necessarily self-evident. Nor does an awareness of other risks influence success or failure. That is, the result indicated is that neither the reason for requesting public support nor awareness of risk factors influences success or failure. Therefore, the point is that a company's preparation of the success factors described in the preceding section, rather than how a project is

positioned, forms the line dividing success from failure.

Given the recent severe business environment, firms are making strong demands internally to boost their commercialization success rate through R&D, and, therefore, the needs for public funds increase. In this situation, public support should be given to “low-risk projects with a short development period” , if a public institution tries only to boost its success rate. When we return to and consider the true necessity of public funds, however, this type of support merely results in an improper situation of emphasizing only a numerical value as the success rate; i.e., the means are mistaken for the ends. Today, firms themselves can be noted to have a tendency to aim at R&D that has a short time horizon. So, making use of public funds with similar time frame is inappropriate when considered from the standpoint of public and private sector roles.

Public support is not something that is worthwhile only if the success rate is high. One problem that has been noted when evaluations are made by emphasizing objectivity and a formulaic approach is that “challenging and risky project themes for which projections are difficult will garner low evaluation points, while project themes on the safe side that are more predictable will obtain high evaluation points.”[8] When public entities try to simply pursue numbers only, they can achieve their results if they support projects that are not accompanied by novelty or innovation. This cannot be deemed the proper direction, however, if the intent of public funding – that is, support for projects where private corporations alone would have difficulty bearing the risks – is considered. Moreover, even if projects fail in the end, that may not be considered a “failure” because the experience of the project can be utilized in other projects in the future[3].

Consequently, when working to improve the success rate, ensuring management

that will continue to maintain quality and improve the success rate as a result becomes an extremely vital issue. That is to say, management should be implemented by positioning the satisfaction of these success factors as the necessary conditional parameter for support. If satisfying all of these conditions is required when adopting projects, the success rate can be expected to improve. Setting the required standards unduly high when selecting projects at the start, on the other hand, could nip promising technologies in the bud. Therefore, when selecting projects for support, if a project can be expected to yield technologically notable results but does not meet these requirements, it is necessary to address this issue as an aspect of progress management once the project has been selected, through progress management adequate to meet the requirements.



Fig. 2 Internal positioning of projects for which firms seek public funds
 (Unit: Number of companies (multiple responses); Black bars indicate the number of companies which regarded each item particularly significant.)

5. Conclusion

We extracted the following five conditions as success factors for R&D implemented using public funds by a private sector firm as the main entity.

- The existence of R&D that preceded the project in question
- The clear position of the R&D theme as part of the company's medium-term management plan and other efforts
- A close cooperative relationship with operating divisions
- A clear understanding of core customers
- The presence of a key researcher who continuously plays a key role as a full-time individual on the project

These quantitatively summarize the results of the questionnaire survey and interviews, and are conceptually consistent with the qualitatively envisaged success factors.

The selection of and focus on high-caliber projects is critical for the effective use of limited, valuable public funds. We believe this can be achieved by managing R&D projects while taking the success factors described above into account.

Specifically these success factors must be incorporated explicitly into the selection and progress management of projects targeted for support. That is, while selecting projects that fulfill these factors, it is important to actively take up projects worthy of public support even if they do not satisfy these parameters, based on recognition of the success factors discussed in this paper. Then, executing management in a form that gives sufficient consideration to the success factors and provides the necessary orientation correction to ensure the success factors are met during the project implementation phase, is an invaluable response.

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