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Improving R&D Project Selection and Evaluation Methods of the Steel Company

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〈Abstract〉

Corporations are pursuing maximum returns from their R&D investment. They are also interested in sound measures to quantify returns. In fact, they use various measures and criteria for measuring returns from the R&D investment. But the fundamental problem is that there is no generic and widely acceptable measures and criteria. To make things more complicated, measures are very powerful and influential to the people in the corporations. Herbert Simon already indicated that people do many things but people usually do their best for the only tasks which are measured. Many researchers, like Chester(1995), are interested in R&D productivity measures and risks because what the company measures really influence R&D people and output.

This article present design concepts of the R&D project selection and evaluation system in POSCO (Pohang Iron & Steel Company). This is an output extract from the 6-month joint activities with POSRI(POSCO Research Institute) researchers and POSCO R&D personnel. Process changes, new organizations and new selection and evaluation criteria are developed to improve R&D performance and to enhance technology management of the POSCO. This article covers new selection and evaluation criteria only. We would like to share our experience about how we redesign the selection and evaluation of R&D projects. We also bring insights how we seamlessly integrate 4 different project selection and evaluation steps as a whole. We hope that this case will give you a clue to improve your R&D management.

Key words : performance, selection, evaluation, criteria, measure, risk, early warning system

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Ⅰ. Introduction

1. Backgrounds

It is a time of great change. Depressions are not a foreign word anymore. Corporations are feeling the impact of current economic chaos. Corporations are shifting from emergency management into survival management. What should corporations and R&D do in this chaos? Corporations have to move both sides. Corporations need internal management enhancements to cut down the cost and to boost employees' moral and external management activities such as restructuring, strategic alliances, market developments to increase revenues.

R&D is only one facet of an integrated business approach. Chester(1995) indicated that corporate R&D strategies have been changing both internally and externally, mirroring overall corporate change. Attempts are also being made to quantify the contribution of R&D to shareholder value by Boer(1994).

R&D has potential drivers to change corpora tions profoundly. Corcoran(1994) focused on innovation process which is being reexamined as a part of corporate changes. And the quest for measuring and enhancing R&D effectiveness and R&D efficiency is continuing efforts of corporations everywhere including POSCO.

2. Steel industry R&D characteristics

Every industry R&D has its unique characteristics. Obviously, there are steel industry R&D characteristics. Kimura and Tezuka(1992) classified steel industry R&D activities into steel materials and manufacturing technologies. It is better to understand more specific steel industry R&D types and their characteristics.

First type is a "Product R&D". Steel products are not final but intermediate ones. Customers use products as materials to produce their final products for end-users. Product R&D focus on not only meeting customer needs but also creating customer needs. Product R&D includes new product development, current product quality enhancement, etc. Second type is a "Process R&D". Steel industry is a heavy capital invested area. There are many performance improvement potential by solving current issues such as quality, cycle time, cost, maintenance, etc. This type of R&D activities are closely related to plant people. Cooperations between researchers and plant people are crucial. Usually this type of R&D project needs not so much time to provide solutions. Third type is a "Trouble Shooting R&D". This is an emergency R&D activity to handle real life emergency situations. Fourth type is a "New Process R&D". Steel industry is a process industry. New Process R&D is aiming for redesigning current processes. This type of R&D needs lots of investment and time. It is a very high risk activity but it gives corporations golden opportunities to become a technical leader in this industry for a long time. This type of R&D activities are COREX, strip casting, etc. Other types are "Customer Service Related R&D", "Demand Boosting R&D", etc.

3. Objectives

There are no single best selection and evaluation criteria. It is very important to customize criteria for each company based on each company's specific situation. Fundamental issues are reviewed based on "rethink" not based on previous procedure before we make any recommendations. Every efforts are toward to improve R&D performance and to enhance technology management of the POSCO.

There are two major outputs in this project. First output is a redesigning R&D project management processes. It starts from the review of current processes. The recommendations include enhancement of previous processes based on "rethink". Second output is enhancing project selection and evaluation methods.

We starts from objectives and benefits of project selection and evaluation system as a whole and then we define each step's objectives, necessities,

principles, guidelines. This article will focus on this part. What we want to achieve from our activities are as follows :

- Motivating researchers with fair evaluation and developing skills of researchers
- Providing formal evaluation guidelines and forms
- Integrating 4 different project and evaluation steps
- Supporting business unit people who have to evaluate R&D projects
- Maximizing R&D Productivity(Performance/Contribution/Return)
- Devising objectives, goal oriented evaluation criteria

II. Project Selection and Evaluation

1. Decision making criteria

There are two distinctive project types in this company. One is the strategic project which is sponsored by the corporate R&D HQ. This project result is applicable to many business units. It needs relatively large investment. The other is the tactic project which is sponsored by businesses unit. This project result is usually applicable to sponsor business unit. Usually this type of business unit directed project needs small investment.

〈TABLE 1〉 Selection & Evaluation Theme and Criteria

Step	Project Selection	On-going Project Evaluation	Project Completion Evaluation	Implementation Evaluation
Theme	Attractiveness	Stop & Go	Milestone	Contribution
Selection & Evaluation Criteria	Expected Output · Technical Factors -Technical Accomplishment · Business Factors -Financial Potentials		Output · Completion Ratio · Technical Competency · ROI	Output · Applicability · Technical Asset Building · Net Profit · Implementation Effort
	· Milestone	· Milestone Check	· Milestone Check	
	· R&D Risk · Production Risk · Market Risk	· Environmental Change -Business -Technology		Overall Contributions

R&D selection decisions and the evaluations are of critical importance for the economic success of many corporations today. Before evaluating and selecting projects, ideas have to be generated and shaped out as proposals. The chosen projects have to be scheduled, updated and monitored after the selection step.

In each step, there is an unique theme at the table 1. In selection, main idea is prioritizing attractive projects to invest. In on-going evaluation, the important thing is deciding whether continue the project or not. In completion evaluation, it is time to check important milestones of the project performed. In implementation evaluation, we eva-

luate the specific project's contributions to the corporations. There are distinctive measures in each step at the table 1.

2. Measures in each step

1) Project Selection Step

Project selection is critical and the most important step of all. Following evaluation steps are mainly monitoring processes but project selection can be a rethinking process and its impact is significant. There are lots of factors to be considered. But it is simply impossible to consider all factors at this time. Therefore, a project must be selected based on critical factors. The results of the selection must show projects value according to corporate objectives. All submitted proposals have to be evaluated before the project selection.

There are multiples objectives in this step. First objective is prioritizing candidate projects based on contribution. Second one is integrating candidate projects with long-term technology strategy. Third one is maximize potential economic returns. Final one is increasing technical competencies through choosing right projects.

We set several principles in place. First, give high priority to the candidate projects which are closely link to technology strategy and great economic potentials. Second, integrate the selection and evaluation process by doing the project proposal must be a decision criteria of next evaluation steps. Third, make the project proposal done by both researchers and counterparts to promote communication and partnership between two groups. Fourth, visualize the qualitative return factors to analyse thoroughly. Fifth, redesign the quantitative return factors to analyse easily. Sixth, decide whether the project on-going evaluation is necessary or not.

Actual evaluation sheet has this measures as follows :

- Alignment with technology strategy
- Project necessity
- Research objectives and research item
- Applicability of research results
- Reasonableness of expected qualitative/quantitative returns
- Appropriateness of on-going projects evaluation

Table 2 is summary chart of changes and directions of improvement. We tried to visualize important qualitative factors as possible.

Critical problems are the risk and uncertainty of the project. Selection models need to be capable of handling some degree of uncertainty because R&D projects results can not be exactly predicted. According to Baker and Freeland(1975), there are categories of risk and uncertainty which are important considerations in this selection step. Technical uncertainty is related to R&D risk, that the product or process fails to achieve the specified technical objectives of the project. Commercial uncertainty is related to production risk, that the product cannot be produced economically. Economic uncertainty is related to market risk, that the product does not yield the expected return. These risks may affect different factors in a project : technology, cost and market.

2) On-going Project Evaluation Step

There are multiples objectives in this step. First objective is deciding project stop and go(early warning system) to prevent investment from unnecessary project whether it is due to technical difficulty or market change. Second one is revising project terms and conditions(T&C) to remove any difficult to perform projects. Final one is motivating communication between counterparts and researchers.

We set several principles in place. First, decide project go/stop/revise based on qualitative analysis. Environmental change includes economic and technical changes. Second, decide project evaluation schedule at the project selection step. Third, simplify evaluation process to increase productivity except abnormal cases.

Actual evaluation sheet has this measures as follows :

- Milestone check
- Assessment of environmental change
- Reasonableness of change requests

〈TABLE 2〉 Redesign of Project Selection

	Pre−Redesign	Redesign Idea	Redesign
Evaluation Measures	· Too Detail Factors	· Structured · Simple and Clear · Emphasis on Technology and Economic Factors	· Alignment with Technology Strategy · Project Background · Applicability of R&D projects · Expected Return −Qualitative −Quantitative
Qualitative Factors	· No Specific Guidelines	· Visualize · Emphasis	· Technological Maturity · Technological Competitive Strength(current status) · Technological Competitive Strength Improvement (status after the project) · Impact
Quantitative Factors	· Few Economic Indicators	· Structure	· Cost · Expected Return · ROI(Return On Investment)
Linkage to following steps	· Vague	· Emphasis	· Following evaluation based on this step
On−going Evaluation	· Unclear	· Increasing Predictability	· Scheduling On−going Project Schedule

Multi−year project must be handle differently. There is summary of this issue in table 3. We tried to confirm schedule for on−going evaluation at the earlier part of the project process.

3) Project Completion Evaluation Step

Few projects need not implementation evaluation. Some of them are not intended to implement, such as a pure research project. Some of them are finished implementation during the normal project period. In these project cases, this step

〈TABLE 3〉 Redesign of On-going Project Evaluation

	Pre-Redesign	Redesign Idea	Redesign
Evaluation Schedule	· No Obligation	· Emphasis	· Evaluation schedule was fixed at the project selection step.
Multiple-term Project(More than 18 months)	· Every new term, project must be selected at the project selection step. Usually it is 2 months ahead of each term project end. And there is a project evaluation when each term ends. Therefore, the company decide new term projects before the company evaluates previous term's output.	· Simple · Reasonable · Minimize administration burden	· On-going project evaluation and project selection perform at the same time.

will be a final evaluation step.

There are multiples objectives in this step. First objective is checking milestones to confirm project major milestones are accomplished. Second one is measuring contribution from technical and economical factors. Third one is evaluating implementation plan to promote usage of R&D output. Fourth one is motivating researchers through fair evaluation. Final one is enhancing customer satisfaction.

We set several principles in place. First, choose valid factors to make sure fairness and objectivity. Second, redesign linkage between previous selection and evaluation results. Third, adjust factor weights between economic return measurable project and economic return unmeasurable project.

Actual evaluation sheet has this measures as follows :

- Completion ratio
- Technical contribution
  (technical competitive strength change, easiness toimplement)
- Economical contribution(expected return, ROI)
- Implementation plan

〈TABLE 4〉 Redesign of Project Completion Evaluation

	Pre-Redesign	Redesign Idea	Redesign
Evaluation Measures	· Detail Factors	· Visualize · Clear · Emphasis	· Completion Ratio · Technical Factors · Economic Factors
Linkage between steps	· Vague	· Focus Linkage	· Closely related to previous steps and following steps
Implementation plan	· Unclear	· Emphasis Implementation of R&D Results.	· Managers of counterpart team complete implementation plan.

Table 4 is a summary chart of changes. We tried to link each steps seamlessly and to enhance implementation.

4) Implementation Evaluation Step

It is quite difficult to evaluate implementation results. There are so many continuing efforts to make right measures. This evaluation results should prove R&D's worth, despite the difficulties of the task.

There are multiples objectives in this step. First objective is encouraging implementation of R&D outputs. Second one is motivating high implementation potential project. Third one is providing valuable R&D performance measurement information to the high management. Fourth one is motivating researchers through fair evaluation. Final one is satisfying customers.

We set several principles in place. Even though this step specially focus on encouraging partnership between researchers and counterparts, this step's objectives are as similar as Project Completion Evaluation Step's. Actual evaluation sheet has this measures as follows :

- Applicability
  (Applicability at the Business Unit, Contribution to technical asset, Expandability)
- Economical contribution(actual return, ROI)
- Implementation Effort(Researcher, Business-Unit)

〈TABLE 5〉 Redesign of Implementation Evaluation

	Pre Redesign	Redesign Idea	Redesign
Evaluation Measures	· Contribution to Operating Skills (Improving Technical Competence, etc) · Economic factor (Expected Return, Productivity Ratio)	· Visualize · Clear · Emphasis Implementation Effort	· Applicability · Economical Contribution · Implementation Effort
Implementation Schedule	· Unclear	· Clear	· Managers of counterpart team commit implementation
Evaluation Sheet	· 3 different criteria for 3 different project types	· Simple	· Single Sheet for every project
Linkage between steps	· Vague	· Emphasis linkage	· Closely related to previous steps and following step

Table 5 is a summary chart of what will change and what is direction of improvement. We tried to link each steps seamlessly and to enhance implementation.

3. Evaluators in selection and evaluation steps

There are two important committees to be considered in regarding to selection and evaluation. The first one is the "Technology Strategy Committee". This committee is composed of

higher-level management in charge of technology, research center, corporate planning and marketing. It is a R&D final decision making group chaired by CTO. It does not only selecting strategic projects but also dealing important R&D and Technology issues. The second one is the "Implementation Review Committee". Implementing research results is getting higher attention than ever before. There are consensus that R&D needs more objective implementation evaluations. This committee is composed of technical experts, business unit staff, and HQ staffs. This committee is going to investigate implementation results once in a year.

Evaluators in each step is shown in the table 6.

〈TABLE 6〉 Evaluators in Selection and Evaluation Steps

Step	Evaluator	
	Strategic Project	Tactic Project
1st : Project Selection	· Technology Strategy Committee	· Business Unit(Technical Staff)
2nd : On-going Project Evaluation	· Business Unit (Technical Staff)	· Business Unit(Technical Staff) · Research Team Manager
3rd : Project Completion Evaluation	· Business Unit · Technical Staff · Research Team Manager	· Business Unit · Technical Staff · Research Team Manager
4th : Implementation Evaluation	· Implementation Review Committee	· Implementation Review Committee

III. Conclusions

Some of the R&D best practices such as 3M, GE, HP, IBM, ABB, Du Pont, etc. According to Gwynne(1995), ABB has no way of directly measuring the value of its R&D but business managers tell R&D they need R&D and use R&D even in the recession.

R&D performance depends on motivation and attitude of people, quality of business and R&D strategy, efficiency of process, rationality of procedure, healthiness of organization, capable resources and so on. R&D performance improving activities are never ending management efforts to achieve corporations goals. Archer(1993) clearly showed multi year Texaco's R&D improving efforts.

This article introduced steel company's R&D improvement efforts focused on process and sound measures. These efforts are on-going efforts to enhance R&D performance than ever before.

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