

A Study of R&D Investment Framework and Success Factors*

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Abstract

This paper presents a framework for implementing R&D project. Fundamental R&D investment process framework and success factors while considering risks and uncertainties of project will be described to illustrate an efficient and effective R&D management system in a firm.

Key Words: R&D project, Risks and Uncertainties, Feasibility Study

1. Introduction

In recent years, the rate of change in industry has been extremely rapid. Competition has increased through new competitors having established segments and, in some cases, a change of competitive weapons. Thus the need to manage new technology effectively becomes ever more urgent in a business climate. However, investment for R&D is always characterized by uncertainty and complexity. The inherent problems of technology investment such as uncertainty of R&D time, fast changing customer needs, high speed of technology innovation, need to be carefully addresses when assessing investment for technology projects.

This paper mainly addresses the issues of status evaluation for technology investment. The standard technology investment assessment models used in other parts of organization were considered inappropriate. However, recent changes in the business environment such as opened market, shortened product life cycle, intensified competition, and advanced information and technology, etc. have focused company-wide attention on R&D's contribution to competitive advantage. R&D in company is no longer considered to have a mere supportive role to the company, but to be a vital part of company (Weed-Nederhof *et al.*, 1997).

A number of studies have explored the framework of R&D projects (Cooper *et al.*, 1998; Park 2004; Farrukh *et al.*, 2004; Seider 2004). Farrukh *et al.* (2004) discussed a company could have a well-established new product development process but still come up against

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problems if it attempts to develop technology and products simultaneously. They proposed how to achieve an integrated process that speeds new products to deliver maximum business benefits by aligning the goals and actions of the new key business functions; R&D and Manufacturing and Supply. Seider (2006) proposed how to improve the engineering productivity and effectiveness of project by applying the theory of constraints. A number of papers have enriched the analysis by taking into account that cooperation between industrial organizations allows firms to increase the possibility of success of new product (Cassiman *et al.*, 2002; Admir *et al.*, 2003). Belderbos (2004) mentioned a limitation of these papers is that they have been strictly focusing on R&D cooperation with supply firms, and have paid little attention to R&D collaboration with firms that are not direct connections. Using the data from 56 individual projects, Davila (2003) investigated the impact of short-term economic incentives upon new product development performance. Furthermore, he examined how the design of incentive systems varies across different characteristics of the product being developed as well as organizational structure around the development effort.

In this paper, a R&D investment process framework and success factors while considering risks and uncertainties of project will be described to illustrate an efficient and effective R&D management system in a firm.

2. R&D Investment Framework

R&D would be defined as for transforming technology into new product design and/or process designs based on customer needs, company strategy, and internal and external environment. R&D investment system is a continuous process, starting from the idea generation and strategic evaluation of R&D, feasibility study, R&D planning, R&D implementation and validation, and then to product realization and feedback as shown in Table 1.

At the first phase, a firm should generate project ideas based on the firm's vision, goals and objectives, and then do initial risk and success analysis and initial estimation of gains and costs. At the second phase, a firm have to consider and identify several constraints such as technology, manpower and financial situation on a firm. And then a firm do specifications and feasibility study of gains and costs, and also identifies project manager, project team, and cross-functional team while considering risks and uncertainties of project. At the third phase, project manager and team members should develop project plan such as finalized project scope, development of work-breakdown structure, and project scheduling and cost estimation. At the same phase, project team should make a detailed analysis and risk reduction plan with a R&D cross-functional team. At the fourth phase, project team implements and manages the R&D project, and continuously measures performance of the project for validating the project. Thus a firm can reduce risks and improve success possibility of the project. After finish the

validation of project, R&D project team and cross-functional team transfer the outputs to operation for product realization.

Table 1. R&D Investment Framework

	Activity	
Phase 1 Idea Generation and Strategic Evaluation	<ul style="list-style-type: none"> • Project idea generation based on vision, goal and objective • Initial risk/success analysis • Initial estimation of gains and costs 	◀ PR and RM
Phase 2 Feasibility	<ul style="list-style-type: none"> • Identify and study constraints <ul style="list-style-type: none"> - technical - manpower - finance • Identify project manager, team members, and cross-functional team • Specifications and feasibility study of gains and costs 	◀ PR and RM
Phase 3 Planning	<ul style="list-style-type: none"> • Develop project plan <ul style="list-style-type: none"> - finalize project scope - develop work breakdown structure - project scheduling/cost estimation • Detailed analysis and risk reduction plan 	◀ PR and RM
Phase 4 Implementation and Validation	<ul style="list-style-type: none"> • Implement project plan • Manage project plan • Performance Measurement • Validation of project 	
Phase 5 Product Realization and Feedback	<ul style="list-style-type: none"> • Transition to operation • Provide performance feedback 	◀ PR and RM



Note: PR: Phase Review RM: Risk Management

3. Success Factors for R&D Investment

The success of R&D investment effort depends on the several factors as shown in Figure 1. Five main sections are CEO leadership and business strategy, management of risks and uncertainties, human resources structure, operating structure, and information and knowledge management. Issues that create the need for R&D project may come from a variety of sources such as the business analysis on the project team, the new technology vendor, or the business itself. Regardless of where the issue of R&D project originates, the project should be evaluated strategically and be studied about feasibility by a firm.

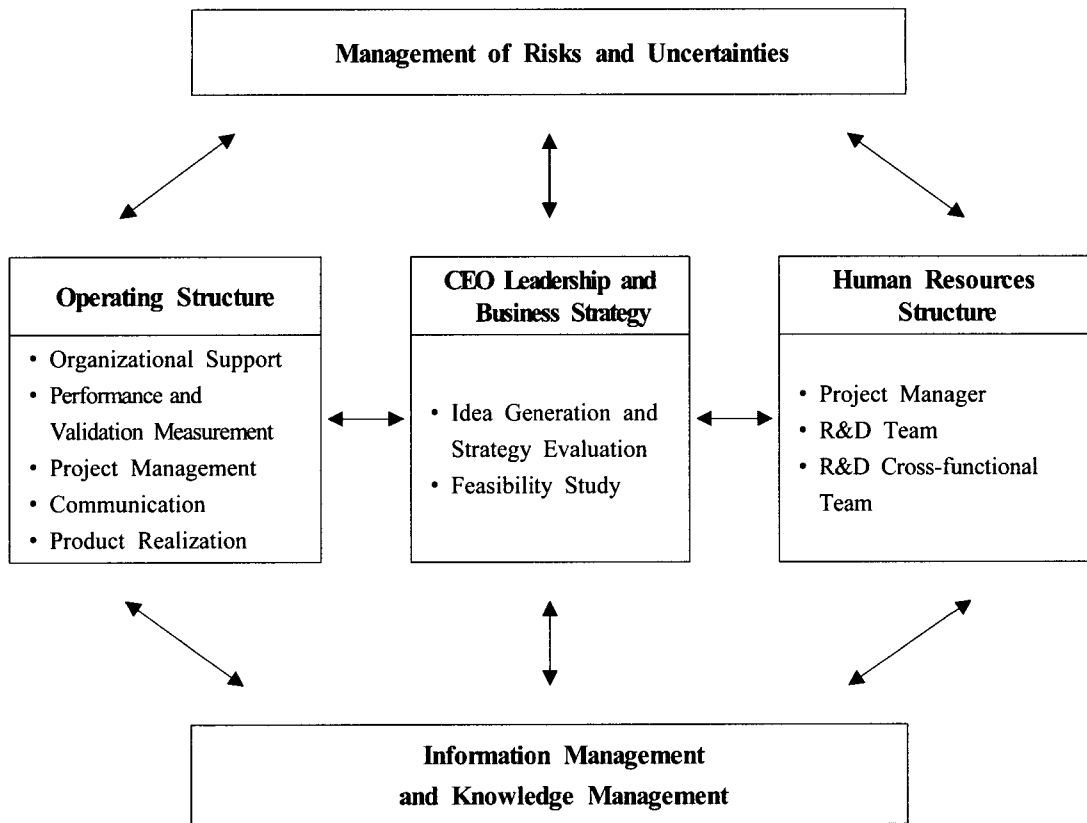


Figure 1. Success Factors for R&D Investment

3.1 Management of Risks and Uncertainties

A risk is an occurrence that has a negative impact on at least one of the project objectives (cost, quality, schedule, customer satisfaction) when it materializes itself. Thus a good R&D project manager has to measure risks in advance. The objectives of the risk management is to establish the feasibility of the R&D project within the organizational structure, economy, and comparative company that limit business. Risk can occur during any phase of a project's life cycle, thus company should be aware of some common ones at each stage. The uncertainty and associated risks decline as managing those effectively at each phase. Sources of uncertainty and associated risks are;

- Market uncertainties
 - customer
 - market size and growth
 - competitors
- Technology uncertainties

- untested technology
- talent of manpower
- learning skills
- Supplier and process uncertainties
 - supplier reliability
 - incompatible product fit
 - production cost and quality
 - product realization timing
- Financial uncertainties
 - availability of capital
 - expected return on investment

Organization can reduce the risks and uncertainties on project through risk management. There are steps to master the project risks as shown at the Figure 2.

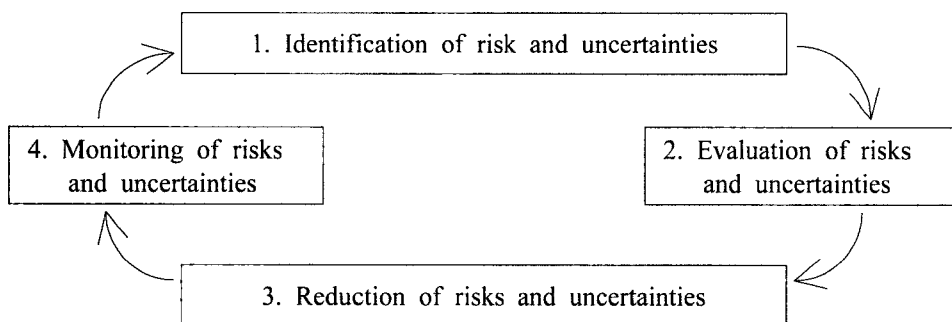


Figure 2. Management of Risks and Uncertainties

▲ **Step 1: Identification of risk and uncertainties**

Identify the risk and uncertainties by listing them and describe their potential impact on the project. Involve the major project leaders focus on causes and responsibilities

▲ **Step 2: Evaluation of risks and uncertainties**

Analyze the probability that the risk will occur and the potential impact of the risk. At here determine the overall risk exposure criticality made by own organization. The risk exposure criticality might be characterized by two variables as shown at Figure 3.

$$\text{Criticality} = \text{severity} \cdot \text{probability}$$

where severity would be a damage extent (impact on the costs, schedule, quality and customer satisfaction).

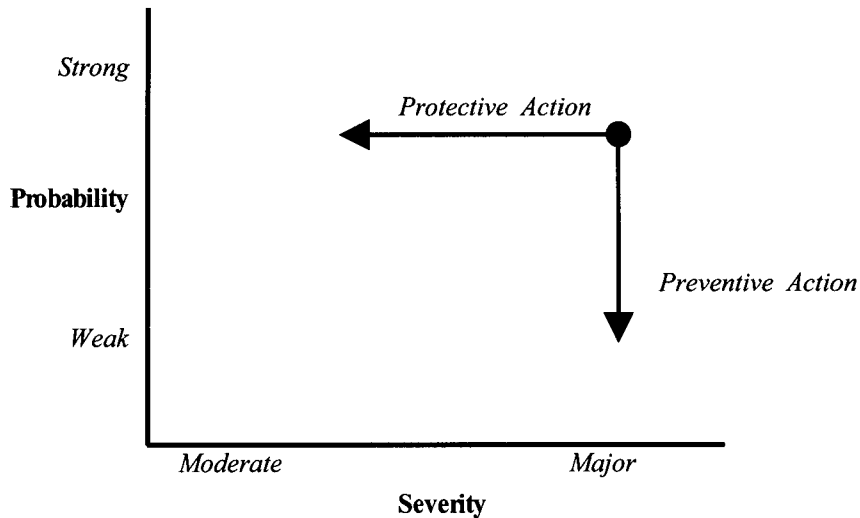


Figure 3. Matrix of Risk Evaluation and Risk Reduction

▲ **Step 3: Reduction of risks and uncertainties**

Determine a strategic action plan to reduce risks. This means organization would delete the part of the project that contains the risk or change the project into another or smaller sub-projects that reduce the overall risks. As shown at Figure 2, preventive action on the causes or protective action on the consequences) will be necessary. Prevention action is to diminish the probability of a risk occurrence on the causes and protective action is to diminish the severity on the consequences.

▲ **Step 4: Monitoring of Risks and uncertainties**

Monitor the risk and develop a contingency plan in case the risk becomes imminent.

3.2 Idea Generation and Strategic Evaluation

Even a good idea can be a bad idea if its goals and scope are not clearly defined before major resources are committed to it in a firm. To be a good R&D project, goals must be specific, realistic, measurable, agreed by project members, and clear responsibility be project members. The four activities are necessary as the followings;

- Formation
 - explain the idea and advantages of the opportunity
 - document explaining the opportunity
- Estimated gains
 - estimation of the expected results upon implementation of the project;
 - what is there to gain if we proceed with the project?
 - what is there to lose if we do not?

- Estimated costs and duration
 - estimation of all costs upon implementation
 - estimation of the expected duration of project
- Initial risk and success analysis
 - estimation of the expected risk and success;
what would make the future project fail or reduce the potential benefits?

After the four activities for evaluating the opportunity, a firm would decide go-the project or no-go-the project. If a firm decide to go the project, firm should nominate a R&D project manager and project members to study the feasibility of the R&D project. However, if a firm not decide to go the project, firm would save the suggested ideas.

3.3 Feasibility Study

Unlike risks, constraints can be identified in advance. Constraints are the real-world limits on the success possibility of the R&D project. Typical constraints on the R&D project are internal technical ability, budget and people. If organization ignore the constraints defining own project, it will fail in some way. Identifying constraints beforehand provides you with time to mitigate those you can fix or to notify the firm that the project may be in jeopardy before it even begins.

A systemic feasibility study of the project considering constraints and risks simultaneously is crucial to get it off an acceptable and workable work. The feasibility study that face to the R&D project would be;

- How much and when money is available?
- How does the firm's financial situation?
- By what date must the project be completed?
- What are the technologies and know-how on which the firm has?
- How does the firm's technology position compare to its competitors?
- What inside resources such as people and equipments are required?
- What outside resources such as are required?

3.4 Project manager and Project Management

Responsibility of the project manager is managing the flow and direction of R&D activities to meet the goals of the firm and also controlling the resources that the R&D research team will need to reach product implementation and commercialization. Project manager should have leadership and business concept and also communication channel with CEO and top officials of the firm to run R&D project more effectively.

Firm have to setup effective project management system and develop a detailed project tactical plan that identifies tasks critical to achieving R&D project goal. Effective project management can result in faster commercialization. On the other hand, if the new research or new product concept is not valid, finishing can be determined sooner, allowing reallocation of resources to more promising development efforts.

3.5 R&D Cross-functional team

Cross-functional team is formed early with the goal of staying together from idea generation through full commercialization, including phase review and risk management at each phase, typically 4-9 members of team size will be good. The results of R&D must adequately address a number of questions such as how the product will be manufactured, how the product provides value to the customers, how the product will successfully compete with present and potential products, what the financial profits to the company might be, and what the product fit with the company's business and technology strategy, R&D team and cross-functional team should communicate and share information in a regular base time.

3.6 Performance Measurement and Validation of Project

There are two major purposes for performance measurement of R&D investment. The first purpose is to motivate R&D team, and the second purpose is to diagnose and validate project activities and organizational units. A diagnose approach can be used to assess if problems can be expected, and a validate approach can be used to assess if product realization can be possible. However, when trying to assess these, major problems are encountered. The first problem would be the time lag between R&D efforts and the potential financial rewards to

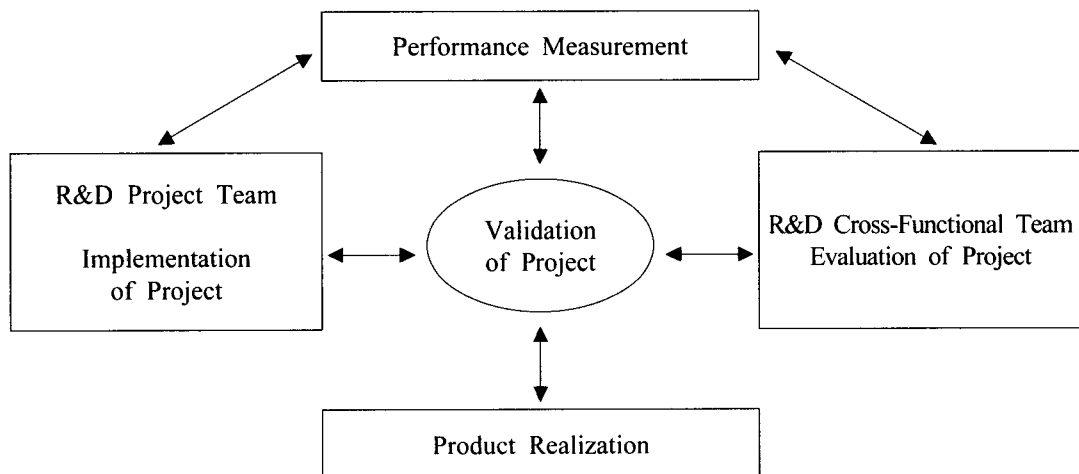


Figure 4. Process for Product Realization

the firm, and the second problem may be the difficulty in isolating the contribution of R&D to company success (Drongelen, 1977). The last problem would be the acceptance of performance measurement by R&D staffs.

3.7 Communications

R&D project manager, team as well as R&D cross-functional team should share a common understanding of the process for the R&D projects. Easy and open communication between R&D team and R&D cross-functional team, including periodic meetings, will be a key role for minimizing a development time, failure rate of product realization and investment of money and people. Communications among teams should emphasize progress versus plans, current issues, how these issues will be resolved, what has been learned, and any significant unknowns that remain. Such communication is very important for successful technology investment.

3.8 Knowledge Management and Information Management

Information is based on data, and adds value to the understanding of a subject and, in context, is the basis for knowledge. Information Management(IM) covers the processes of selecting, capturing, categorizing, indexing and storing information. Knowledge is a set of data and information, and a combination of know-how, experience, values, ideas, networking skills, communication skills which can be used to improve the capacity to act and support decision making. Knowledge management (KM) is the management of activities and processes for leveraging knowledge to enhance competitiveness through better use and creation of individual and collective knowledge resources. IM and KM can be a basis for implementing R&D in a firm.

4. Conclusions

The aim of this paper was to study a framework for implementing R&D project. Fundamental R&D investment process framework and success factors while considering risks and uncertainties of R&D project was described to illustrate an efficient and effective R&D management system in a firm. The study also indicated how typical constraints such as internal technical ability, budget and people are considered during a R&D project process.

References

1. Asociación Amir, R., Evstigneev, I., and Wooders, J.(2003), "Noncooperative versus cooperative R&D with endogenous spillover rates," *Games and Economic Behavior*, Vol. 42.
2. Belderbos, R., Carree, M., and Lokshin, B.(2004), "Cooperative R&D and Firm Performance," *Research Policy*, Vol. 33.
3. Campbell G. and Baker, S.(2007), "Project Management," Alpha.
4. Cooper, R., Edgett, S., and Kleinschmidt, E.(1998), "Best Practices for Managing R&D Portfolios," *Research Technology Management*, July-August.
5. Davila, Antonio(2003), "Short-term Economic Incentives in New Product Development," *Research Policy*, Vol. 32.
6. Dorf, R. and Byers, T.(2005), "Technology Ventures; From Idea to Enterprise," McGraw-Hill International Edition.
7. Drongelen, I. and Cook, A.(1997), "Design Principles for the Development of Measurement Systems for Research and Development Process," *R&D Management*, Vol. 27.
8. Farrukh, C., Feaser, P., and *et al.*(2004), "Developing an Integrated Technology Management Process," *Research Technology Management*, July-August.
9. Park, Young Hyun(2004), "A Study of Technology Investment Assessment Model," *The Asian Journal on Quality*, Vol. 5.
10. Seider, R.(2004), "Project Portfolio Management," *Conference on the Product Development Management*, October.
11. Seider, R.(2004), "Optimizing Project Portfolios," *Research Technology Management*, Sept.-October.
12. Weerd-Nederhof, P. C, Harten, W., and Hermens, J.(1997), "Assessing R&D Quality Rehabilitation Technology Development," *Research and Development Management*, Vol. 27.