

The Relationship between Technology Planning Capability Enhancement, the Technology Roadmap, and Innovation

Won-Il Lee

Abstract—This paper studies the link between enhanced technology planning capabilities, the adoption of a technology roadmap, and innovation in organization in R&D organizations. A case study approach was used to examine the implementation of a technology management framework, the degree of institutionalization of a technology roadmap, and the impact on innovation. Based on the case analysis, the following propositions are suggested. (P1) The establishment of a technology management framework can have a positive effect on the adoption and utilization of a technology roadmap. (P2) The adoption and utilization of a technology roadmap map can have a positive effect on innovation within an organization. Thus, this study analyzes the mechanism of technology planning and its effect on innovation within an organization.

Index Terms—Technology planning, technology roadmap, R&D organization.

I. INTRODUCTION

In hypercompetitive business environments, the launch of new, innovative products can be the principal focus [1]. To successfully launch innovative products, it is necessary for the R&D and product planning teams to engage in technology planning [1]–[3]. Furthermore, technology planning may be connected to management performance. Thus, I conducted a case study to examine the relationship between a firm's technology planning capability and management performance. In today's unstable business environment, many organizations are adopting technology planning tools and utilizing them for both product planning and R&D planning [4], [5]. To achieve a successful relationship between technology planning and management performance, technology planning should be established and routinized through a technology management framework. Through a case study analysis, this paper examines the effect of technology planning on management performance. I analyze the mechanism and relationship between the technology management framework, technology planning capability, and innovation in the organization.

Manuscript received October 18, 2014; revised December 29, 2014. This research was supported by newly appointed professor research fund of Hanbat National University in 2012.

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II. LITERATURE REVIEW

A. Strategic Technology Management

Strategic technology management started in 1980 in the United States. In the United States, there is a huge gap between technology and management, which has eroded its competitive advantage against Japan [2], [3], [5]. With the purpose of creating synergy between technology and management, the new academic field of technology management emerged [2], [3], [5]. Technology management combines areas such as searching, protecting, exploitation, and management of new, core technologies [3]. In technology management today, aligning a firm's technology strategy with its competitive strategy and business strategy is one of the most important issues. To survive in a hypercompetitive business environment, organizations should be capable of managing their technology strategically [2], [3], [5]. Through strategic technology management architecture, organizations can continuously produce new and innovative products and services. Before the concept of technology management became widely accepted, the concept of core competency was regarded as the strategic architecture for achieving successful product launches [6].

Today, the core competency is considered the strategic architecture for managing core technology and for aligning technology strategy with competitive strategy.

Furthermore, in a hypercompetitive business environment, management of technology (MOT) may be the best solution for balancing technological exploration and exploitation. This can be done through MOT practices such as technology foresight, planning, management, and evaluation and commercialization [5], [7], [8].

At present, the concept of MOT encompasses R&D management as well as strategic decision making for the acquisition of outside technology like Fig. 1 [9]. In other words, MOT comprises the overall management activities related to the efficient acquisition, management, and utilization of both hard and soft technologies for organizational competitiveness and technology commercialization [9].

An organization can employ the MOT framework to search for new technological information and resources (i.e., technological exploration) as well as to better utilize existing organizational resources (i.e., technological exploitation) [9].

Technology management systems have evolved from their first generation to their fourth generation. First-generation technology management systems facilitate lab-level R&D

management, whereas second-generation systems address needs at the R&D project management level [10], [11]. Third-generation systems integrate strategy and R&D management. However, to achieve the most productive R&D system, it is necessary to align strategy, R&D portfolio management, and R&D project management. It is this integration that has given rise to fourth-generation technology management systems [10], [11].

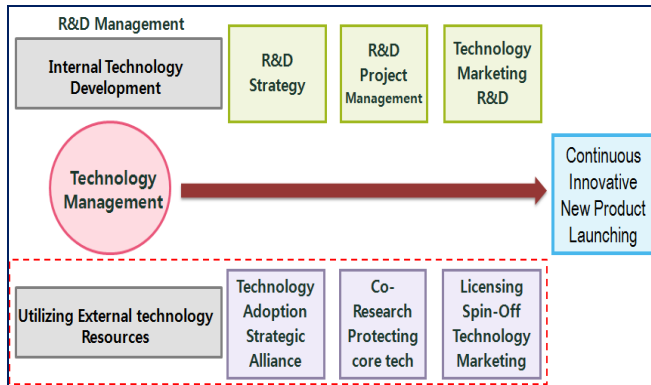


Fig. 1. Balancing internal technology development and utilizing external technology resources. Source: Revised from J. T. Bae, “The framework for technology management,” 2006 [9].

B. Technology Management Framework

The technology management framework can be categorized in various ways. This paper defines the technology management framework as the alignment of technology strategy with business strategy, agile project management for technological innovation, and R&D organizational management as an infrastructure for technological innovation [1], [2]. This technology management framework should be suited to the external environment and internal sub-systems [1], [2]. First, business strategy, competitive strategy, and technology strategy should be aligned [1], [2], [12]. Second, an agile R&D project management system should be adopted to facilitate technological innovation. Third, the characteristics of R&D professionals should be considered, and the R&D organization should be managed. These sub-systems should be integrated and aligned with each other [2].

In technology-intensive organizations, utilizing this technology management framework enables continuous technological innovation. In addition to facilitating internal technological innovation, the framework helps organizations better use technological resources outside the organization as well. For example, the framework allows for rapid new product launches based on capabilities such as outside technology adoption, strategic alliances, and technology cooperation, not to mention increased internal technology development capabilities [1], [2], [12].

When the companies can coordinate internal capability for technology development and the capability for utilizing outside technology resources, the companies can continuously and successfully launch new products at the right time and gain a competitive advantage [1]–[3], [12]. Thus, in hypercompetitive firms, the formula for success is to manage the technology capabilities both “inside” and

“outside” the organization [1]–[3], [9], [12].

C. Technology Planning Capability Enhancement

There are various tools for technology planning, such as technology foresight, scenario planning, cross-impact analysis, and technology roadmaps [13], [14]. Through the adoption and utilization of these various tools, technology organizations can systematically search and plan for emerging technologies [15], [16]. Adoption and utilization involves the institutionalization of a technology planning tool in the R&D department [8]. Adoption and utilizing a technology roadmap can provide the infrastructure for technological innovation [8], [20]. When there is an inconsistency in the R&D system, no clear R&D vision in the organization, or a lack of a strategic core technology, it is time to use the technology roadmap [16]–[18]. Through the technology roadmap, R&D departments can align their business strategy, technology strategy, and R&D system [16]–[18]. Technology roadmaps have information regarding the market, product, and technology like Fig. 2 [16]–[18]. In addition to current competition situation, technology roadmaps can link the present with the future through a foresight activity [16]–[18]. Utilizing the technology roadmap means that R&D activities are implemented based on the roadmap, and that the R&D project team members share the roadmap formally and update it continually [8].

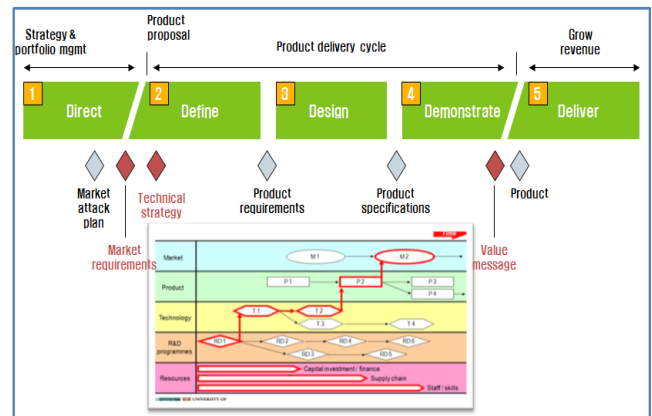


Fig. 2. The technology roadmap is a powerful technology planning tool. Source: Revised from Gail L. Rein, “From experience: Creating Synergy between marketing and research and development,” 2004 [20].

Therefore, once the R&D project teams are using the technology roadmap, the R&D department and the roadmap can be considered coupled. Thus, the technology nodes and links in the technology roadmap can be continually converted into R&D action plans and, ultimately, R&D activities [8]. By institutionalizing the technology roadmap, organizations can increase their technology intelligence capability and produce more innovative products. The R&D, marketing, and strategy planning departments can communicate via the technology roadmap, as it contains information regarding the market, product, and technology.

An enhanced technology planning capability should be connected with both product and management performance. Through a case study approach, this paper examines how the adoption of a technology roadmap influences technology planning capability.

III. CASE STUDY ANALYSIS

Based on the literature review, I used a case study approach to analyze the following factors: implementation of a technology management framework, institutionalization of the technology roadmap, and product innovation.

TABLE I: CASE STUDY ANALYSIS

Case study framework	Subcategory	Company A	Company B	Company C
Technology management framework establishment ▼ ▼ ▼	Alignment of technology strategy with competitive strategy	●	●	◎
	Agile R&D project management for technological innovation	●	◎	◎
	R&D organization management considering the characteristics of R&D professionals	●	◎	○
Institutionalization of technology roadmap (adoption and utilization of TRM) ▼ ▼ ▼	Top management support for the utilization of technology roadmap, foresight, and scenario planning	●	◎	◎
	IT system support for technology planning	◎	○	○
	R&D project guided by the technology roadmap	●	◎	○
Linkage with innovation in R&D organization	Product performance linkage	●	◎	◎
	Management performance linkage	●	◎	◎

Note: ○ < ◎ < ●

Company a Analysis

The case study was analyzed using the theoretical background of the technology management framework, institutionalization of the technology roadmap, and linkage with innovation like Fig. 3. Company A was already using the technology management framework. A new project management system had been adopted, and projects were being managed strategically. R&D human resource management (HRM) was being managed with consideration of the characteristics of R&D professionals. A customized career management system was also being utilized. With the advent of the global company in Korea, Company A needed to create a technology roadmap to direct its R&D system toward a new vision.

To increase its technological capability, Company A decided to create a concrete technology roadmap for the organization. To this end, Company A formed a special consulting team to initiate the technology roadmap process. After adopting the technology roadmap throughout the organization, various efforts were made by the management

support team to help the R&D project team utilize the roadmap more effectively. The CEO encouraged all of the R&D researchers to participate in roadmap workshops and education programs. In addition, to strengthen the relational capability of the R&D project teams, a technological and formal cooperation meeting was created for the R&D project teams. After these meetings and discussions aimed at solving technological problems and building relational capabilities, each project team could understand the other technology areas, search for new opportunities for technical cooperation, and find new innovation patterns.

Consequently, each R&D project team actively used the technology roadmap as a technical guidance tool. After institutionalizing the technology roadmap, Company A was able to launch a more innovative service in the market. Both the revenue and market share of Company A increased, and high growth is anticipated in the future.



Fig. 3. Enhanced technology planning leads to technological innovation.

IV. RESEARCH FINDINGS

This paper employs a case study approach to examine the relationship between the enhancement of technology planning capabilities, the adoption of a technology roadmap, and innovation. The case study was analyzed using the following sequence: implementation of the technology management framework, institutionalization of the technology roadmap, and innovation.

Based on the case study analysis, the following propositions are suggested:

P1: The implementation of a technology management framework in the organization can have a positive effect on the adoption and utilization of the technology roadmap.

P2: The adoption and utilization of a technology roadmap can have a positive effect on innovation in organization.

V. CONCLUSION

In this hypercompetitive business environment, technology management is increasingly important for systematic technological innovation. Using a case study approach, this paper analyzed the use of a technology management framework, institutionalization of a technology roadmap, and innovation within an organization. Company K has the capabilities of technology management and technology planning and, thus, produces innovative products. Through launching these innovative new products, the organization is poised to thrive in the future. Although this paper analyzed only company K, multiple case studies and statistical analyses are possible in future studies.

ACKNOWLEDGEMENT

This research was supported by newly appointed professor research fund of Hanbat National University in 2012.

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