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Abstract

A literature survey revealed that the single word "roadmap" has surfaced as a popular metaphor for planning resources for science and technology development [1]. The variant term of "roadmapping" is a new verb that describes the process of roadmap development. In this paper, roadmapping process is identified to be an interactive process and achieve higher likelihood of promoting knowledge flow and facilitating knowledge integration within and among an organization(s). Based on core competence and knowledge-based view, it is shown that organization's core competence can be strengthened more effectively and firmly through roadmapping process due to its feature as an effective collective learning. Consequently, more competitive advantage is established and sustained by using roadmapping approach.

1. Introduction

▪ *Roadmap and roadmapping*

Technology roadmapping has become a popular activity in all sub-areas of technology over the last ten years. There exists no single universal definition of what a roadmap is and how it should be constructed [2]. A roadmap, in its general definition, is the view of a group of stakeholders as to how to achieve their desired objective [3]. The roadmap identifies future direction, main challenges, intermediate milestones and their interrelationships [2].

Roadmapping refers to the process of formulating and updating a roadmap. It offers a framework to visually integrate market, product, and technology evolution [4, 5]. Using the framework, gather information from various sources to strategically develop plans for various objectives such as R&D investment, new product development and so on. Some authors also claims that it is a learning process [6, 7], which confirms to our perspective of roadmapping elaborated about later.

▪ *The major concern of this study*

As an emerging field [1], roadmapping approach has begun to catch attention from business, industry,

government and academy all around the world. Researchers are studying on the issue from various perspectives. Literature shows that the overall view is positive and encouraging, and many people even see roadmapping technique as the solution for technology driven firms to survive and win the increasingly severe competition. By a deep investigation into the roadmapping process, we found that roadmapping practice displays a great potential in developing firm's core competences due to the collective learning feature [7] intrinsically contained in the knowledge integration process. We propose to improve firm's core competence by roadmapping approach, by leveraging its interactive learning mechanism. So far, since there is few attempt to link roadmapping approach with firm's core competence, this study is aim at exploring the untouched area, to academically fill the gap and meanwhile to provide firms an practical way to develop their core competences.

2. Core Competence and Knowledge Based View

▪ *Core Competence*

In 1990, in their influential paper—"The core competence of the corporation", C.K. Prahalad and Gary Hamel propose a "competence tree model" to illustrate the root of competitive advantage. "The diversified corporation is a large tree. The trunk and major limbs are core products, the smaller branches are business units, the leaves, flowers, and fruit are end products. The root system that provides nourishment, sustenance, and stability is the core competence" [8]. They coined the term core competencies and further stated that: "Core competencies are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies. Core competence is communication, involvement, and a deep commitment to working across organizational boundaries. It involves many levels of people and all functions..."[8]. Using the cases, they pointed out that core competences are the source of competitive advantage and enable the firm to introduce an array of new products and services. For a core competence to be enduring and ensuring firms the

competitive advantage, it needs to be dynamic. The competence must be continuously updated and/ or changing to maintain their value in the marketplace for competitive advantage. However, these dynamic core competences do not come over night; they require technological and skill accumulation over time.

Confirming to the original description of the term of core competence, some researchers believe, like Yogesh Malhotra, that collective learning builds core competence, particularly how to coordinate diverse production skills and integrate multiple streams of technology. Competencies are developed when they are applied and shared [8]. Competences are enhanced by synergy resulting from skill, capability, methods operating in harmonious unison [9]. With the complex harmonization and integration, competences are not tied to an individual but embedded in the processes of firms' routines [10] and therefore are difficult to copy.

▪ **Knowledge-based view**

An emerging knowledge-based view (KBV) of strategy underlies this study. This perspective considers knowledge as the most strategically significant resource of the firm [11], and its proponents argue that heterogeneous knowledge bases and capabilities among firms are the main determinants of sustained competitive advantage and superior corporate performance [12, 13]. Dierickx and Cool [14] made first attempt to integrate insights related to KBV into theory of strategy. They conceptualized the knowledge of firms in terms of stocks and flows. Stocks of knowledge are accumulated knowledge assets, while flows are knowledge streams within and across organizations that contribute to the accumulation of knowledge. Superior stocks and flows are seen as sources of sustained competitive advantage and superior performance. Kogut and Zander (1992) also emphasized the strategic importance of knowledge as a source of advantage. They argued that what firms do better than markets is the creation and transfer of knowledge within the organization. The knowledge of the firm evolves in a path-dependent way, through the replication and recombination of existing knowledge [15]. Knowledge is considered socially constructed and the creation of meaning occurs in ongoing social interactions grounded in working practices [16]. Grant [17] proposed a knowledge-based theory of strategy. He argues sustained competitive advantage is determined by non-proprietary knowledge in the form of tacit individual knowledge, due to the unique and relatively immobile nature. Yet, because that

knowledge is possessed by individuals and not by the organization, a critical element of sustained competitive advantage is the ability to integrate the specialized and tacit knowledge of individuals.

3. Roadmapping—a collective learning and knowledge integration process

While the technology roadmapping approach has been used successfully in a number of big companies, the implementation of the approach is challenging [5]. A typical roadmap developing process, known as T-plan, is proposed by Robert Phaal et al at University of Cambridge for achieving a fast start and 'alive' maintenance. The standard T-Plan process involves a series of four workshops (Fig 1.), respectively focusing on the following activities [5]:

1. Identification of market and business drivers
2. Generation of product features concepts
3. Identification of technology solution options
4. Charting of milestones, product and technology evolution

During the T-plan roadmapping process, deep involvement and commitment of participants (usually from different function departments of the firm) are observed regarding the three layers—market, product, technology (sometimes resources, capabilities and skill are also considered if required), and the linkage of milestones in various layers.

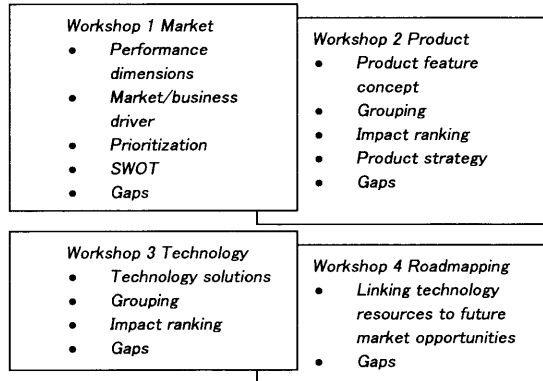


Figure 1.—The standard T-Plan process consists of four workshops Source: [5]

Although there are also different ways to formulate roadmaps, it has been found that the common features are obvious—the participants with multi-disciplines make an explorative effort by committing to an information acquisition, experience sharing and knowledge integration and creation process so as to step forward to a common objective. By our looking into

roadmapping processes, the following characteristics are identified:

- Roadmapping process stresses on the information acquisition from various aspects (externally: changes of state policy, laws and regulation, market needs, future trends, new industry standards etc.; internally: technological information, resources from various function department, etc.). Roadmaps are knowledge-capture tools for the company [18].
- Roadmapping process stresses on internal and external analysis—Identifying needs, gaps, strengths and weaknesses [19], classifying, integrating internal resource and capabilities, and then matching internal resource and capabilities with requirements of external changes.
- Roadmapping activities offer a unique arena and opportunity by bringing a variety of specialists with varied experiences together for sharing mental models, experiences [7] and generating new knowledge. Roadmapping provides a “ba” where the specialized and tacit knowledge of individuals could be integrated.
- Roadmapping process itself is a process of knowledge integration and cross-functional coordination. The roadmapping process creates linkage, linking strategic choices based on market needs and the competitive environment to product evolution and feature implementations, and then linking product plans to technology implementation plans [19]. In this sense, it shows great potential in building core competence.

From the first three points, we can find that roadmapping process is a continuous and iterative collective learning process through which the knowledge flow can be potentially facilitated so as to achieve an optimum allocation of knowledge resource, and through which new combination and creation of knowledge are completed.

It is the iterative collective learning, integrating and coordinating activities that ensure a constant accumulation of knowledge, experience, and an unceasing renewal of competences.

Since 1990s, the view towards the source of competitive advantage has changed with the birth and development of the concept of “core competence” and Knowledge-Based View. There also emerged the terms like competence-based view, competence-based management, competence-based competition. Firms have been seeking the competence-building methods, as they know that to lead to competitive advantage, competence must be continually developed in advance of competitors. In this study, from collective

learning perspective, roadmapping is considered to be a promising practice for competence-building objectives. When discussing the issue of building competence by roadmapping practice, one aspect needs addressed. The argument that roadmapping is a collective learning process and the enhancement of firm’s core competences is the result of collective learning may raise question like: other processes involving team works, like planning, designing, manufacturing also contain collective learning feature, but what superior features make roadmapping exceed other processes in terms of building competences?

Learning can be understood as the process that transforms information into knowledge and then into wisdom [20]. We suggest that in a broad sense, in a firm, many processes involving the conversion from information to wisdom can be called as collective learning, through which firm’s competences are strengthened. The reason for roadmapping practice to be outstanding may be put in this way: the roadmapping process, as an initial step, represents exploration for a complex matter, and it usually addresses matters of complete difference. Thus, the challenges are the unknown in the future and no precedent to follow. Nevertheless, it is such an explorative practice that is able to display great significance for competence-building efforts. It is worth noticing:

1. There is so much uncertainty that the situation can hardly be mastered easily, which represents a strict learning period.
2. It is the beginning of the whole efforts that sets the goal and direction, and identifies risks, which represents a rather critical period of time.
3. As no precedent to be followed, participants could be encouraged to make a creative attempt, which tends to result in differentiation with competitors.
4. At the beginning of an exploration for complex matter, participants have not reached the tacit understanding and agreement with each other, which may produce the higher heterogeneity. The high degree of heterogeneity can be a good challenge for managing and coordinating, but also tends to stimulate an effective collective learning due to the strong dynamic interaction.
5. When the matter under discussion shows high degree of heterogeneity, it is hardly to find a format for the way of seeking solutions. Thus, the core competence developed under this condition could hardly be imitated.

4. Concluding remarks

In the preceding sections, we have given a brief overview of core competence and knowledge-based view and argued roadmapping practice has great

potential in developing core competence through collective learning characterizing knowledge integration and creation. We also suggest:

1. The collective learning process observed in roadmapping practice should not be a mere repetition, but a process with creativeness due to the collective confrontation with the situation of difference. As a result, competences of difference are strengthened.
2. It also should not be a mere information acquiring and processing process, but an inspiring process with interaction, constructive discussion and even challenging debate.
3. Core competence is to be strengthened only by an ongoing roadmapping process. In this process a continuous updating process is important to assure the iterative learning to be continued.
4. Time dimension provides the critical information for firms to follow, and milestones serve as intermediate goals and help firms in measuring the progress. In our view, competences could be effectively strengthened only by those roadmapping processes where the information provided by time dimension receives adequate attention. Any competence-building efforts overlooking the time framework will make no sense.

5. For further research

Some globally leading companies, like Motorola, Rockwell Automation, have recognized the competence-building function by roadmapping practice [17]. We make the proposal to appeal firm's attention to this perspective. In introducing the technique into Japan, there seems to be lots of work to persuade Japanese companies who tend to doubt the effectiveness of roadmapping approach due to lack of successful cases or practices conducted in Japan. Further efforts in disseminating roadmapping approach to and promoting roadmapping practice with Japanese companies are essential. For future research, we think that a comparative study of roadmapping approach with other planning methods may help firms understand the essence of their distinctions so that they can make an easy choice for their particular needs. We are also going closely to interpret the working mechanism through roadmapping practice strengthens core competence, so as to promote a wide acceptance of this promising approach.

Acknowledgments

The authors sincerely appreciate the colleague students from Graduate School of Knowledge Science of JAIST for their discussion through the lab meetings.

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