



Development of a new technology product evaluation model for assessing commercialization opportunities using Delphi method and fuzzy AHP approach



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ARTICLE INFO

Keywords:

Technology commercialization
FAHP
New product development (NPD)
Delphi
Commercialization assessment

ABSTRACT

As the number of new products developed by new technologies has increased, the importance of the commercialization of new technology products has become crucial to manufactures in the successful delivery of valuable new products and services. This study classified success factors for commercialization of new products and analyzed which factors should be primarily considered. Based on the literature review and Delphi method, we identified four decision areas and further prioritized the sixteen factors under a hierarchy model structured by fuzzy AHP (analytic hierarchy process) approach. The FAHP is conducted by 111 R&D and business experts working at the world's major players in machinery industry; using the priorities of success factors derived by FAHP, we devise an example of commercialization assessment model. The paper drives the assessment initiatives of the new product development in manufactures and provides them with practical implications about the commercialization of new technology product.

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1. Introduction

As technologies change rapidly, most companies experiencing successful growth are facing pressure for the development of new technology products. Previous studies have reported that new products produced by new technologies have resulted in a 40% to 90% increase in national wealth in most countries (Campbell, 1983; Lee et al., 2009). Many companies are aware of the strategic importance of technology commercialization and have been trying to develop innovative technology products.

For successful new product development (NPD), technology is the one of the most commonly cited success factors (Atuahene-Gima, 1996; Bastic, 2004). Balachandra and Friar (1997) analyzed the success factors of NPD, and found that the firms' technological resources influence the success of NPD. However, new technologies are often initially targeted to the wrong market for commercialization. The most challenging problem facing firms is how the new product or technology successfully commercialized given a high level of market uncertainty.

Most studies have emphasized the significant role of the market research, which includes market, customer, and competitor analysis in stimulating the need for a new product (Gatignon and Xuereb, 1997; Jaworski and Kohli, 1993; Ruekert, 1992). These

studies have asserted that company need to adopt a market-oriented perspective in delivering valuable new products. Moreover, in the case of machinery products (specialized defense and industrial products such as shipbuilding, plant construction, and steel), such industrial product development projects are extremely expensive and risky as the products are manufactured in a small quantity in response to a specific technological request from a customer. As only the customized technology turns out to be of extraordinary value in the specialized industrial products, the development of machinery products should be the result of a proactive R&D of technology that takes into account the demands and preferences of an industrial customer beforehand.

Therefore, it is essential to incorporate the assessment of commercial opportunity before new product development projects are launched. The new technology product development process requires an integrated framework to be put into place to ensure that the firms' technological resources are aligned with market and customers' needs. Furthermore, firms' technology capabilities should be considered in the new technology product development decision-making process in order to know how to accomplish the desired result in their product, by identifying market and customers' needs. Previous studies have focused on the general market or business factors for successful new product development, but we expand these factors and develop a new technology product assessment model that incorporates the commercialization opportunity and the technology capability factors simultaneously.

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This research prioritizes the factors that should be considered for new technology product development from multiple dimensions based on market opportunity and the technology resource-based approach for the preliminary assessment before launching an NPD project. From this, we identify commercialization evaluating factors for the development of the new products and examine what factors should be primarily considered. Based on the literature review and Delphi study with expert members from the machinery industry, four decision areas are identified: marketability, business feasibility, technological competitiveness, and R&D capabilities. We then prioritize the sixteen factors under a hierarchy model which is identified by the fuzzy analytic hierarchy process (FAHP) approach. The identification and prioritization of factors for commercialization of new technology products presented in this paper improve the conventional technology valuation model and will provide new insights for the experts of technology planning, R&D, and strategy department of companies.

The paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the proposed research framework and the research method. Section 4 presents the results, and fifth section shows the application of case study. Finally, the last section concludes the paper.

2. Literature review

2.1. New technology product development strategies

Technology could be regarded kind of a product that develops saleable products or sales in the market as a license (Mitchell and Singh, 1996). According to Novelli and Rao (2007), technology commercialization strategies could be defined using two types of strategies. The first strategy is to sell the technology as disembodied good to other firms that should develop it. The second strategy is for the company to commercialize the technology by incorporating it into technological systems or products. Generally, manufacturing companies use the second technology commercialization strategy because machinery technology is regarded as product-based technology (Bae and Lee, 1986). In this research, we aim to highlight this second perspective and develop the assessment model of the commercialization of new technology for machinery companies.

For successful NPD process, most studies argue that the firms' technological resources and capabilities can serve as a major source of the development of new products (Baker and Sinkula, 2005; Verona, 1999). Verona (1999) proposed a comprehensive firm resource-based view of the NPD model. The study argues that firms' technological capabilities and organizational capabilities contribute most to the NPD performance. This resource-based view assumes firm resources as the key success factors of NPD. In particular, as the market or business environment changes rapidly, the firms' ability to use internal resources becomes more important source of competitive advantage to the development of new products.

On the other hand, several studies have argued that market opportunity perspective is essential to the success of NPD (Chien, 2010; Im and Workman, 2004). To develop successful products, management must be aware of market-oriented approach in order to closely track applicable market trends by investigating the target customers, market opportunities, and competitors (Gatignon and Xuereb, 1997; Jaworski and Kohli, 1993; Ruekert, 1992). Many successful firms create a new product by filling up emerging voids in the market and satisfying new needs of their customers (Stanković and Dukić, 2004). Narver et al. (2004) argued that management needs to take market demands into consideration instead of simply focusing on product specification.

Based on this literature review, the NPD process should consider commercialization opportunities as both market opportunity factors and the firm's technology resource factors simultaneously.

2.2. Market opportunity and technology resource-based approach to NPD

In order to implement AHP technology assessment model, we need to derive some decision criteria used for the assessment process. Thus, we attempt to extract the commercialization feasibility and technology capability criteria and convert them into four strategic criteria for evaluation.

2.2.1. Commercialization feasibility: marketability and business feasibility

To commercialize technology, companies have to decide what product or technology would be appropriate to target for the market. Calantone and Di Benedetto (1988) and Li and Calantone (1998) specified that market analysis is necessary for improving NPD performance. Previous studies widely suggest that new product development projects should be selected according to marketability which are related to the market competition (Bastic, 2004; Cooper, 1994; Parry and Song, 1994; Zirger and Maidique, 1990) and market potential (Bastic, 2004; Cooper, 1984).

Dwyer and Mellor (1991) pointed out that business analysis is also an important determinant for the development of the new product. The managers of an NPD project should have sufficient information regarding how the market will grow and change in the business environment. Cooper (1984) and Song and Parry (1997) recommended conducting a business feasibility analysis to increase the success probability of NPD. A business feasibility analysis typically involves the traditional financial performance measures, which are usually related to profitability, expected time to commercialization, and commercialization cost. Furthermore, synergy with the base business is also considerable factor for business feasibility analysis of NPD (Montoya-Weiss and Calantone, 1994; Parry and Song, 1994).

In line with previous literature, marketability and business feasibility are applied and adapted as the criteria to improve the commercialization possibility of technology product in order to assess the commercialization feasibility of new technology product development project properly (Song and Parry, 1997).

2.2.2. Technology capability: technological competitiveness and R&D capabilities

For technology commercialization, technology competitiveness is the most important factor (Atuahene-Gima, 1996; Bastic, 2004). Balachandra and Friar (1999) pointed out that the more innovative technology is, the more likely is it to allow customers to do something beneficial through a greater breadth of technologies embodied in new products.

Moreover, since the R&D for NPD project is conducted by cross-functional teams, R&D capability factors are also considered as critical factors for improving the likelihood of NPD success (Atuahene-Gima, 1996; Benedetto, 1999; Cooper, 1994; Langerak et al., 2004; Parry and Song, 1994). R&D capabilities factors are generally related to firms' resource allocation and organizational climate related to NPD process. If the NPD process and R&D organization are well-organized, the technologies used in the development of the project would also be widely available to the organization. Souder and Song (1998) argued that organizational factors such as experiences, know-how, and professionalism of employees are related to improvement of NPD capabilities. R&D employees should have a wide spectrum of experience and expertise in the design and implementation of new technology products.

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