Effects of marketing-manufacturing integration on product innovativeness and competitive advantage under uncertainty*

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Abstract

This paper aims to examine influences of marketing-manufacturing integration (MMI) on product innovativeness and new product competitive advantage in new product development (NPD) stages. Path analysis shows negative relationship between MMI in technical development stage and product innovativeness. Also, demand and supply uncertainty were shown to moderate the relationship between product innovativeness and competitive advantage.

Ⅰ. Introduction

New product development (NPD) is one of innovation process and can be defined as "the technical, industrial and commercial steps that lead to the marketing of new manufactured products" (Central Advisory Council on Science and Technology, 1968).

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It is also considered to be critical way of maintaining corporate's competitive advantage (White, 1976) and therefore improving viability (Hayhurst, 1968). Therefore, NPD is a flexible means of taking advantage of a company's strong points and changes to provide a competitive advantage. Also, it is a significant device in the profit-making process system (Goulding, 1983). A model of NPD has been suggested via empirical test (Zirger and Maidique, 1990). It identified the followings to influence product outcomes: the quality of the R&D organization, the technical performance of the product, product's value to the customer and the synergy of the new product with the firm's existing competences. A cross-national comparative study of new product development processes were conducted based on the Japanese and U.S. new product data. The results showed a robust correlation between the new product successes and sources of advantage, quality of implementation and positional advantages (Song and Parry, 1997). As new product development (NPD) speed is becoming a crucial factor in time-sensitive business innovation, there has been increasing attention on NPD speed as well. The meta-analysis review has been carried on to generalize the relationships between NPD speed and prior researches that are categorized into four sections; strategy, project, process and team (Chen, Damanpour and Reilly, 2010).

Marketing-manufacturing integration has been deemed as something to improve NPD. There have been long and rigorous researches on the advantages and disadvantages of marketing-manufacturing integration (MMI) in new product development (NPD). Marketing and manufacturing are considered to have the most countering perspectives in NPD (Kahn and Mentzer, 1994; Tatikonda and Montoya-Weiss, 2001). Therefore, it is essential that both the perspectives and goals of marketing and the manufacturing are reflected in the overall NPD process. Integration of this sort is thought to lead to improved product competitiveness.

However, marketing-manufacturing integration has been treated as subsidiary factor that affects NPD. Therefore, there needs to be more focus on marketing-manufacturing integration (MMI) itself previous to applying it on NPD. Supply and demand uncertainty will be considered within MMI, as demand uncertainty is crucial in marketing and both of these uncertainties are critical element in manufacturing (Fisher,

1997; Lee, 2002). As overall uncertainties that occur turbulent environment are not useful (Duncan, 1972), they need to be studied in the relations to specific component. In this paper, we will examine whether uncertainties moderate the level of marketing-manufacturing integration, hence the relationship of marketing-manufacturing integration and the new product performance.

Ⅱ. Literature Review

2.1 MMI and NPD

Previous researches have notified the impact of cross-functional integration on new product development (NPD). Patterns of cooperation among marketing, operations and R&D at early and final stages of NPD was examined in order to find out whether simply increasing the level of functional integration contribute to the firm's performance of new products(Olson et al, 2001). Effects of manufacturing practices and strategy integration were conducted, showing that manufacturing and strategy integration plays central role on new product flexibility capabilities (Swink, Narashimhan and Kim, 2005). The studies then became more specific to MMI in that the nature of the marketing and manufacturing interface in NPD was fulfilled (Calantone et al, 2002). Exploratory empirical investigation proposed path model for assessing the impact of marketing and manufacturing interface on the overall business performance and marketing-manufacturing morale. Both business' profit performance and marketing-manufacturing morale enhanced when marketing and manufacturing work together harmoniously for goal attainment (Hausman, Montgonery and Roth, 2002). The relationship between cross-functional integration and new product success was thoroughly examined by empirical research (Troy et al, 2008). This study suggested that though cross-functional integration has direct impact on new product success, the combination of integration with other variables may be of greater importance. For instance, integration in combination with other management-controlled, researcher-controlled, and context-specific factors can improve or alleviate new product success.

Further studies have been conducted focused on MMI. Moderating effects of busi-

ness strategy and demand uncertainty have been examined on the relationship between the integration of manufacturing and marketing-based decisions and organizational performance. The results of this study support the relationship between integration of manufacturing and marketing decision and firm performance is moderated by a firm's business strategy and environmental uncertainty (O'Leary-Kelly and Flores, 2002). Effects of MMI on NPD time and competitive advantage have been studied (Swink and Song, 2007). Both advantages and disadvantages of MMI on NPD timing as well as its influence on NPD quality were examined. Also, it has contribution to the prior researches in that many concentrations have been given to the impact of MMI on both earlier and latter stages of NPD. Another research of Swink and Song has suggested the need of study on how levels of MMI should differ across various stages of new product development for high and low levels of product innovativeness (Swink and Song, 2009). Relationship between manufacturing and marketing integration, managerial priorities and business performance was evaluated based on cumulative capabilities approach (Pavia, 2010). Also, impact of integrating the R&D, marketing, and manufacturing functions on the effectiveness and efficiency of new product development projects was evaluated (Brettel et al, 2011). A multi-functional design was applied that considers three functions, including manufacturing. Further, the study distinguished between two phases of the NPD process, by development and commercialization phases. The result showed that integration between R&D and marketing positively influences on efficiency but not effectiveness across different types of projects. Findings on integration between R&D and manufacturing show a strong positive impact on efficiency in the development phase.

On the other hand, there are many researchers who claim that cross-functional integration is not required in every stage of NPD. Also, cross-functional integration not only provides benefits for NPD, but also requires significant amount of costs. This is because building consensus among manufacturing, marketing and R&D groups who have different perspectives and goals require extra time and effort (Song et al, 1998). Based on interviews conducted in four of North America's largest multinational computer and telecommunications firms, the study insists that manufacturing's in-

tegration into the front-end of new product development process can suppress creative ideas on products' design (Gerwin, 1993). In contrast, too much involvement of marketing can disturb focusing on technical problems in production enhancement (Atuahene-Gima and Evangelista, 2000).

In this article, we expand the theory describing influence of MMI on NPD stages. This study makes important contributions by considering other variables affecting the relationship between MMI and NPD. Demand and supply uncertainty will be considered as moderating factors to find out whether they enhance or mitigate the impact of MMI on NPD, thus competitive advantage of new products.

2.2 Uncertainty

There have been rigorous researches on the uncertainty with the concept of product and process innovations. Uncertainty and innovation processes were examined by evaluating adoption and implementation of new manufacturing processes (Gerwin and Tarondeau, 1982).

Uncertainty was then considered in new product development. Structural model of the impact of the strategic orientation of the firm on the new product performance was proposed. Specifically, this study showed that a competitive orientation was useful to market innovations when demand is not too uncertainty but has to be less underlined in highly uncertain markets (Gatignon and Xuereb, 1997). Also, firms operating in uncertain environments were found out to adopt higher levels of integrated product development practices than firms operating in lower uncertainty (Koufteros et al, 2002). Effects of innovation and imitation strategies on new product performance were compared. Here, the benefits of an innovation strategy were proved to become stronger when market demand is increasingly uncertain (Zhou, 2006).

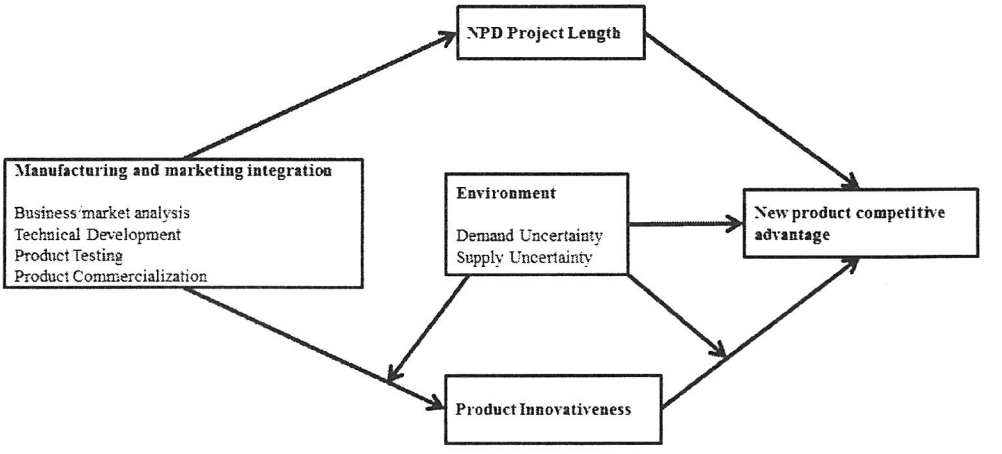
Demand uncertainty has been highly considered in marketing related issues. Jaworski and Ajay K. Kohli (1993) showed a firm connection between a market orientation and performances across environmental conditions such as shifting degrees of market uncertainty. Using the Asian economic crisis in Thailand as a research sample, the market orientation is also found to be useful for managing crisis in the conditions of

high demand uncertainty. However, economic crisis tend to slow down the competition on new product innovations, as it requires extra costs (Grewal & Tansuhaj, 2001).

Uncertainty about demand is crucial for the responsive supply of innovative products. To design a responsive supply process, it is crucial that managers understand the demand uncertainty and seek for the solutions right for the firms' situation (Fisher, 1997).

On the other hand, supply chain uncertainty has been taken into account in the manufacturing department. Three distinct sources of uncertainty that pester flexible supply chain have been notified: suppliers, manufacturing and customer (Davis, 1993). Relative impact of supply, process and demand uncertainty on supply chain competitiveness was evaluated (Bhatnagar and Sohal, 2005). These uncertainties were proved to have negative effects on supply chain performance, supporting the earlier research of Davis (1993). A structural approach has been carried on to measure demand, supply and manufacturing uncertainty. The results provide a confirmed uncertainty scale that help interpreting supply-chain problems (Ho, Chi and Tai, 2005). There were further researches on the supply chain uncertainties. The direct effect of supply chain uncertainties on strategic supply management was examined, along with the following influence of strategic supply management on both buyer and supplier performances (Paulraj and Chen, 2007).

Ⅲ. Theory Development



In this paper, **marketing-manufacturing integration** is defined as the coordination of the two fields when performing functional strategies and development activities in new product development (Swink and Song, 2007).

The effects of marketing-manufacturing integration (MMI) are examined according to the following four stages in NPD. These four stages are divided based on the work of Urban and Hauser (1993) and impact of marketing-manufacturing integration (MMI) on these stages is examined by Swink and Song (2007).

- Business/market analysis: Object of this stage is to understand the new product's place in the market relative to competition, to make connections between new product features and potential customers' needs and forecast the required investment and risk of the NPD project.
- Technical development: This stage includes product and process engineering studies, establishing game designs and specifications, prototyping the product, and approving final designs.
- Market Testing: Key customers are selected, markets are tested and then results are analyzed.
- Product Commercialization: Includes activities required to launch the product including manufacturing and marketing planning, production ramp-up and product promotion and distribution.

Demand **uncertainty** in this paper is variations in customer demand which involves unknowns of product characteristics and environments. Failure to deliver as required by the customer caused by a malfunctioning production process at the supplier or late delivery will be considered as uncertainty in supply. Uncertainty in manufacturing consists of product quality, manufacturing lead-time (Ho, Chi and Tai, 2005).

For the NPD performance, **product competitive advantage** will be also considered as the product performance. Product competitive advantage is suitable for representing NPD performance as it connotes product's desirability to customers in the point of marketing and performance, conformance and reliability in a manufacturing concern

(Song and Swink, 2007).

Product innovativeness in this paper is the level of product newness to the firm (Song and Parry, 1999). It includes the innovativeness of a product's technology, the effect of the product in the industry and the newness of the product's class to the firm (Song and Parry, 1997).

NPD length in this paper is the total length of time needed in order to finish the whole new product development project.

3.1 Effects of marketing-manufacturing integration on product innovativeness and NPD length

Teams with low superordinate identity are less likely to discover complex and novel linkages among market needs, technology and the company's resources whereas high superordinate identity in a team can override the adverse effects of interfunctional biases and stereotypes (Ashforth and Mael, 1989). Therefore, the level of superordinate identity in a cross-functional product development team is positively related to new product innovativeness (Sethi, Smith and Park, 2001). In the similar context, we can expect that marketing-manufacturing integration is positive effect to the product innovativeness. Previous researches also support the evidence on positive effect of cross-functional collaboration on product innovation performance (Griffin and Hauser 1996; Luo, Slotegraaf, and Pan 2006; Song and Parry 1997).

Furthermore, achieving cross-functional integration increases the costs of NPD efforts. In order to find out whether firms can achieve NPD success in a more cost-saving manner, uncertainties were considered as moderator. Suitable degree of cross-functional integration can be examined according to the level of uncertainties are discerned. The moderating effects of technical and market uncertainty on relationship of R&D/marketing integration & R&D/customer integration and NPD effectiveness were studied (Souder, Sherman and Davies-Cooper, 1998). The results suggested that technical and demand uncertainty influence some aspects of NPD effectiveness. Therefore, whether both demand and supply uncertainties moderate the relationship between marketing-manufacturing integration and the project performance will be examined.

Hypothesis 1-1: Demand uncertainty in NPD project will moderate the relationship between MMI in NPD and the product innovativeness.

Hypothesis 1-1a: Demand uncertainty in NPD project will moderate the relationship between MMI during the business/market analysis stage of NPD and the product innovativeness.

Hypothesis 1-1b: Demand uncertainty in NPD project will moderate the relationship between MMI during the technical development stage of NPD and the product innovativeness.

Hypothesis 1-1c: Demand uncertainty in NPD project will moderate the relationship between MMI during the product testing stage of NPD and the product innovativeness.

Hypothesis 1-1d: Demand uncertainty in NPD project will moderate the relationship between MMI during the product commercialization stage of NPD and the product innovativeness.

Based on the work of Fisher (1997) and Lee (2002), it is clear that managing demand and supply uncertainties are crucial in manufacturing. Therefore, supply uncertainty has to be considered when marketing-manufacturing integration takes place as reducing problems occurred by supply uncertainty enables firms to earn competitive advantage (Hau L. Lee, 2002). The moderating effects of supply uncertainty on the relationship between marketing-manufacturing integration and the project performance will be considered similarly as the case of demand uncertainty.

Hypothesis 1-2: Supply uncertainty in NPD project will moderate the relationship between MMI in NPD and the product innovativeness.

Hypothesis 1-2a: Supply uncertainty in NPD project will moderate the relationship between MMI during the business/market analysis stage of NPD and the product innovativeness.

Hypothesis 1-2b: Supply uncertainty in NPD project will moderate the relationship between MMI during the technical development stage of

NPD and the product innovativeness.

Hypothesis 1-3c: Supply uncertainty in NPD project will moderate the relationship between MMI during the product testing stage of NPD and the product innovativeness.

Hypothesis 1-4d: Supply uncertainty in NPD project will moderate the relationship between MMI during the product commercialization stage of NPD and the product innovativeness.

It is examined that new product cycle time can be approved by the greater use of team processes (Ragatz, Handfiel and Petersen, 2002). Previous researches provides evidence that projects with dedicated team members complete the projects faster (Maber, Muth, and Schmenner, 1992) and time to market can be significantly reduced if cross-functional and well-integrated teams are established (Calantone and Di Benedetto, 2000).

Hypothesis 2: The increased marketing-manufacturing integration in NPD projects is positively associated with project lead-time.

Hypothesis 2a: The increased marketing-manufacturing integration in business/market analysis stage of NPD is positively associated with project lead-time.

Hypothesis 2b: The increased marketing-manufacturing integration in technical development stage of NPD is positively associated with project lead-time.

Hypothesis 2c.: The increased marketing-manufacturing integration in product testing stage of NPD is positively associated with project lead-time.

Hypothesis 2d: The increased marketing-manufacturing integration in product commercialization stage of NPD is positively associated with project lead-time.

3.2 Effects of poduct innovativeness on new product competitive advantage

Under the assumption that product innovation takes place with the aim of creating competitive product, the advantage of offering superior product compared to the competitor will stem from the innovativeness of the product. Past researches also showed that product innovativeness is positively related to the product advantage (Holak and Lehmann, 1990; Kleinschmidt and Cooper, 1991; Henard and Szymanski, 2001).

Innovation and competitive advantage is considered to be connected by complex and multidimensional relationships. Making product and market choices that underline high value factors and exclude low value factors /differentiations were examined in the previous paper (Lengnick-Hall, 1992). Previous researches defined that initial screening and market assessments andmarket study in depth is required for innovativeness to give positive results on firms' performance (Kleinschmidt and Cooper, 1991). Demonstrating sustainable competitive advantage requires longitudinal data as competitive environment influences firm's performance. Therefore, sustained competitive advantage in highly uncertain environment including raw materials and product volume were examined empirically (Dreyer and Gronhaug, 2004).

Hypothesis 3-1: Demand uncertainty will moderate the relationship between the product innovativeness and the competitive advantage.

Hypothesis 3-2: Supply uncertainty will moderate the relationship between the product innovativeness and the competitive advantage.

3.3 Effects of NPD length on product competitive advantage

There have been rigorous researches on the time-oriented competition, first-mover strategy, fast-follower strategy, fast product development cycle time, and on-time schedule performances (Lambert and Slater 1999; Chowdhury, and. Lukas, 2002). It is considered that the leading companies manage time in new product development in order to represent the most powerful new sources of competitive advantage (Stalk, 1988).

In a study of 692 NPD projects, the relationship between speed-to-market and new product success was examined under different conditions of uncertainty. The results indicate that speed-to-market is generally positively associated with overall new product success, and market uncertainty was found to moderate the direct effect (Chen, Reilly and Lynn, 2005). Supply uncertainty was considered with demand uncertainty as this paper seeks the overall influence of marketing-manufacturing integration on the firm performance.

Hypothesis 4-1: Demand uncertainty will moderate the relationship between the project length and product competitive advantage.

Hypothesis 4-2: Supply uncertainty will moderate the relationship between the project length and product competitive advantage.

Ⅳ. Conclusion

This paper contributes to the previous researches for the following reasons.

1. First, this study provides further evidence considering environment conditions within the marketing and manufacturing integration. Especially, supply uncertainty is taken into account as manufacturing takes place for cross-functional integration.
2. Second, uncertainties were considered as moderating effects to examine the relationships between marketing-manufacturing integration (MMI) in NPD and product innovativeness, product innovativeness and competitive advantage and project length and competitive advantage.
3. Third, the product innovativeness and competitive advantage were distinguished and have been utilized as elements of single new product performances. This paper tries to link influence of MMI in NPD stages and the following effect of these product performances respectively.

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