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Conceptual Modeling for User Innovation and NPD Project Success in Japan Firms

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Abstract:
Existing literatures on user innovation and new product development (NPD) have been debated rencently, the notion of the importance of user innovation, and NPD project success have caught a big attention in previous researches. Studies show that, firms following user innovation recognize the value of user experience into the process of NPD. Additionally, user collaboration brings stable and long-term successful results for new products. However, few scholars have explained how user innovation effect on NPD project success. Therefore, based on emperical findings, The purpose of this paper is to propose a conceptual model for evaluating user innovation implementation in NPD project success, focuing on the three determinants to reveal the relationship between the user innovation and the new product development success: Degree of product market and technological newness, R&D strategy, User expertise. Meanwhile, we consider the effectiveness and efficiency as measuring factors of NPD success.

Keywords*: Conceptual Model, User Innovation, Japanese firms, R&D strategy, NPD project success*

1. Introduction

Since the concept of user innovation was theoretical documented in "The Sources of Innovation" (von Hippel, 1988). Numerous researches emphasized the importance of user innovation (Chatterji & Fabrizio, 2007; Shah & Tripsas, 2007), and as a source of novel technologies and products innovation literature (von Hippel, 1976; 1977; 1986; 1987; 1988; Finkelstein & von Hippel, 1979).

On the other hand, prior literatures have studied the process and benefits of NPD (Abir & Mamoghli, 2010; Bhuiyan, 2011; Brand, 2001; Kapoor & Sinha, 2013) since its role as a key factor in business planning have been well documented (Booz, Allen Hamilton, 1982; Crawford, 1987; Urban & Hauser, 1993; Cooper, 2001;). For decades, a large number of researches have conducted on critical success factors for NPD (Baker *et al*., 1986; Balachandra & Friar, 1997; Bhuiyan, 2011; Cooper & Kleinschmidt, 1995; Lester, 1998; Lynn *et al*.,1999; Poolton & Barclay,1998; Spivey *et al*., 1997; Voss, 1985). For example, the new product strategy (Wind, 1982); the market orientation (Ernest, 2002; Souder *et al*., 1997); low cost, high quality, superior performance and unique attributes (Clark & Wheelwright, 1993); technology sources (Kappel, 2001). In conclusion, a widely used term is triple constraints of project success, which are time, budget and scope (Gemunden *et al*., 2005).

Correspondingly, user innovation by firms is by definition about process innovation (de Jong & von Hippel, 2009; Gault & von Hippel, 2009; von Hippel, 2005). Moreover, positive impact of users as innovators on NPD success has been established in research and practice (Enkel *et al*., 2005; Ogawa & Piller, 2006; von Hippel, 2005), and scholars have more recently begun to conduct surveys in the field of user innovation (Bogers, 2009; de Jong & von Hippel, 2009; Lhuillery & Bogers, 2006). This means in a wide variety of product domains, that users are an crtical and frequent source of NPD project.

Additionally, (Baker *et al*., 1986; Voss, 1985) have suggested that innovative ideas or creating prototypes of innovative products from users, and collaborations (Littler *et al*., 1998; Mikkola *et al*., 2004) with users can be utilized in NPD processes and develop new business models.

However, these studies are based primarily on western firms, and focus on industries. Recently, rather few of theoretical and empirical works have clearly indicate the relationship between user innovation and NPD Project success of Japanese firms.

In this vein, the purpose of this paper is to present a coherent theoretical model for our review, that explains how user innovation effect on NPD Project success. More specifically, we articulate the conditions under the degree of product market, technological newness, how R&D strategy work, and how user expertise result in NPD Project success. These factors are derived from the general user innovation implementation theories.

The remainder of this paper contains three sections. We first introduce the background of research. In section 2, we develop hypotheses which are based on the results of literature review. A conceptual model presented in section 3. In section 4, we conclude and present the paper avenues with implications and future research.

2.Theoretical Background and Hypotheses

2.1. User Expertise

From the user 's perspective, Mullins and Sutherland (1998) identified that potential customers cannot easily articulate needs to a new product concept. Whereas, Fuchs and Schreier (2011) revealed that firms empowering their customers during NPD enhance competitive advantage in the market place.

Specifically, customers are so-called 'lead users'-at the leading edge and early phases of innovation projects, sufficiently well innovative and motivated to make significant contributions to the NPD or services have become important (Barabba & Zaltman, 1991; Herstatt & von Hippel, 1992; Lilien *et al*., 2002; von Hippel, 1986; 1988; Zaltman, 2003).

Moreover, von Hippel (1986) argued that lead users contributed to the design and development of products. At new product idea generation phase, several published studies have reported that lead user-centered approach played a crtical role (Franke & von Hippel, 2003; Herstatt & von Hippel, 1992; Lilien *et al*. 2002; Morrison *et al*., 2000; Urban & von Hippel, 1988). Lilien *et al*. (2002) also found that lead user approach significantly positive impact on the newness of innovation, the expected turnover, the market share, and the strategic importance of 3M Company.

From the firm's perspective, recent studies have identified that lead users with high level of innovativeness characteristics such as: being ahead of a target market trend, high expected benefits, user expertise and motivation, extreme user needs as well as opinion leadership should be integrated into the firm's NPD process (Bilgram *et al*., 2008; Marchi *et al*., 2011). Not only lead users, ordinary users can also provide valuable ideas for NPD (Kristensson *et al*. 2004) . Futermore, Poetz and Schreierr (2012) futher explicitly studied the value of user versus professional ideas emerging in a crowdsourced NPD process, showed that, while ideas developed by professionals in the firm tend to be more feasible, user ideas exhibited a higher degree of novelty and promise clearer customer benefits .

2.1.1. User Expertise and User Innovation Implementation

The literature on user innovation generally defines users as economic actors— which can be both firms and consumers—that expect to benefit from using a certain technology, in contrast to selling it (von Hippel, 2005). Based on previous research (Franke & Shah 2003; Lüthje *et al*. 2002; Morrison *et al*., 2000; Morrison, *et al*., 2004), a strong correlation between lead users and user innovation was found. Zu'bi (2016) measured lead users collaboration in NPD by multiple regression analysis, showed that lead users' collaboration in NPD significantly affected innovation behavior. Moreover, empirical studied showed that a sigficant support for the link between the amount of experience and knowledgeable users and user innovation implementation (Franke & Shah, 2002; von Hippel, 1988; Lu¨thje *et al*., 2002). The reason is that expert users in a given product field have correspondingly lower innovation-related costs and are more likely to innovate (Lüthje, 2004). Futhermore, von Hippel (2005) summarised that user innovations in general, as well as commercially attractive ones in particular, tend to be developed by lead users.

Therefore, we hypothesize that:

H1: The user innovation implementation is positively affected by high level of user expertise.

2.2. NPD Project Success

According to Verworn *et al*. (2008), there are two key factors as measurement of success : efficiency and effectiveness. The NPD project efficiency is a function of the degree to which the NPD project can economically transform inputs into outputs. Effectiveness is related to corporate image, target market share, and customer satisfaction, and emphasizes a long-term outcome (Chen & Lin, 2011).

In this study, efficiency refers to cost-efficiency of technologies; required technological support; quality of applied technologies;lead time efficiency, while effectiveness refers to meeti profit targets, sales volume targets, market share targets and customer's satisfaction.

2.2.1. NPD Project Efficiency and Project Effectiveness

The key factors influencing NPD effectiveness such as NPD teams'creativity (Amabile, 1997; Im & Workman Jr., 2004; Martins & Terblanche, 2003; McAdam & McClelland, 2002); structural capital (Edvinsson & Sullivan, 1996); new product vision (Cox *et al*.,2003; Lynn & Akgün, 2001); new product competitive advantages (Chen & Lin, 2011; Swink & Song, 2007; Zhan *et al.*, 2009). Among other factors, interpersonal trust has been a major factor for both efficiency and effectiveness of NPD (Bstieler, 2006; De Dreu, 2006; Iacono & Weisband, 1997).

Several empirical researches showed a strong correlation between success factors, effectiveness of the NPD projects is positively affected by efficiency of NPD projects (Dvir & Lechler, 2004; Verworn *et al*., 2008; Verworn, 2009). Thus, here comes hypothesis 2:

Hypothesis 2: The effectiveness of NPD project is positively affected by NPD efficiency.

2.2.2 User Innovation and NPD Project Success

Not only the users with high level of capability and motivation are prompted to become the initial developers of NPD (Zu'bi, 2016), users who have previous knowledge and stored experience in creative problem solving are also concerned (Marsh *et al*., 1999; Perkins, 1988; von Hippel, 1986).

Empirical researches have illustrated that experienced users and user's needs (Hars & Ou, 2002; Lakhani & Wolf, 2005) in industrial markets often played a dominant role in NPD.

Studies of the origins of successful innovation have indicated that users, have been shown to play an important, and sometimes dominant, role in the innovation process across a wide range of industrial sectors (von Hippel, 1976; 1977; 1978; Gardiner & Rothwell, 1985; Spital, 1979; Shaw, 1985).
Then, Füller (2006) implied that user innovation was one of the motivation for consumers engage in NPD because they can benefit from using their innovation.
Accordingly, Veryzer and Mozota (2005) based on their conceptual framework (see in Figure1), and examined the user-oriented design (UOD) contribute positively to NPD.

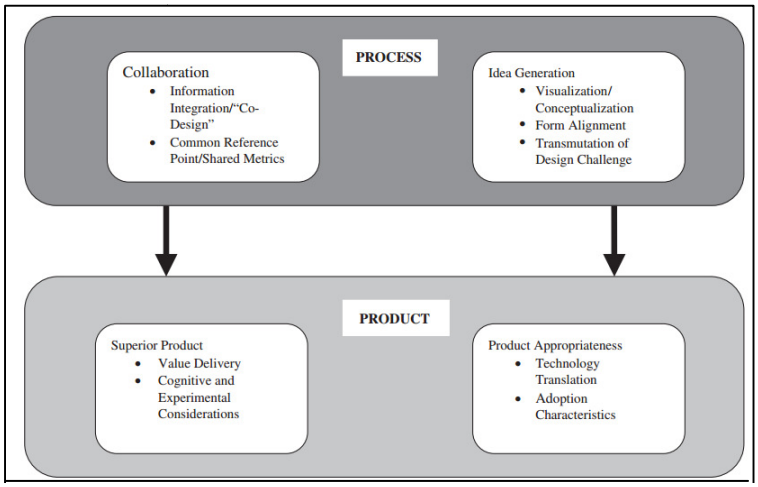

Figure 1: User-Oriented Design Impact on NPD in Veryzer and Mozota (2005)

As user intergration has been emphasized in a study of essential activities in NPD. There might be strong causal relationship between the user innovation and the NPD project success. However, little was known about the relationship bewteen user expertise and efficiency or effectiveness of NPD. Hypotheses 3 and 4 are as follows:
Therefore, we hypothesize that:

H3a: The efficiency of NPD project is positively affected by high level of user expertise.
H3b: The effectiveness of NPD project is positively affected by high level of user expertise.
H4a: User innovation implementation is positively related to the efficiency of NPD project.
H4b: User innovation implementation is positively related to the effectiveness of NPD project.

2.3. Degree of Product Market, Technological Newness

Several studies clarify that the difficulty of a project could change according to the product newness or innovativeness (Verworn *et al*., 2008; Verworn, 2009; Mammetseyidov & Nagahira, 2015). The degree of newness are consisted of 11 items (Booz, Allen Hamilton, 1982). Regularly, highly innovative products are signified as having a high degree of newness (Kleinschmidt & Cooper's, 1991), notably as market and technological to the perspective of the firm (Garcia & Calantone, 2002). Similarily, according to (Meyer & Roberts, 1984; 1986) the product newness is consisted of technology newness and market, based on the conditions existent at the time of each product's development. Moreover, technological and marketing resources were found as newness elements of new products innovation (Verma, 2010).
In this study, we adopt 'degree of market newness' (difference in target market, distribution channels, and advertisement of new product), 'degree of technical newness' (difference in technical components, product lines, processes and knowledge required) to analyze.

2.3.1. Degree of Product Market, Technological Newness and User Innovation

The degree of newness of a product determines how much information must be gathered by a firm to develop a new product. Ziamou (1999) suggested that technology-driven innovations necessitate a novel user input to provide an existing functionality that consumers are already familiar with. Specific user needs required to customize a high degree of technological and market newness (Meyer & Roberts, 1984). As users can be functionally fixed to their current use context and therefore unable to develop radically new ideas (von Hippel, 1986). On the other hand, it is difficult for users to validly evaluate concepts and prototypes of the high degree of technological newness (Urban *et al*., 1996; Veryzer, 1998).
Thus, based on previous research, the degree of a product newness and user innovation activities are might strongly correlated. We hypothesize that:

H4a: The high level user expertise is positively affected by the high degree of product market, technological newness.
H4b: The user innovation implementation is negatively affected by the high degree of product market, technological newness.

2.3.2. Degree of Product Market, Technological Newness and NPD Project Success

The degree of newness or degree of innovativeness of a NPD project was identified as a key contextual factor (Griffin & Page, 1996; Khurana & Rosenthal, 1998; Moenaert *et al*., 1995; Verworn *et al*., 2008; Verworn, 2009; Nagahira *et al*., 2015).

Several studies provide the negative link between the degree of product market, technological newness and the NPD project success (Salomo *et al*., 2007; Verworn, 2009; Mammetseyidov & Nagahira, 2015). Researchers state that the higher the degree of newness more uncertainty exists in the NPD process. Consequently, the difficulty of execution results in higher degree of failure.

Therefore, we hypothesize that:

H5a: The efficiency of NPD project is negatively affected by the high degree of product market, technological newness.

H5b: The effectiveness of NPD project is negatively affected by the high degree of product market, technological newness.

2.4. R&D strategy

Several empirical studies (Gupta *et al*.,1986; Lu & Chang, 2002; Song & Thieme, 2006) have defined that R&D strategy is an essential ingredient for achieving superior R&D performance of NPD.

2.4.1. Degree of Product Market, Technological Newness and R&D Strategy

(Kohli & Jaworski, 1990; Bacon *et al*., 1994; Brockhoff, 2003; Callahan & Lasry, 2004) suggested that a higher degree of product newness, reduced innovation risks and more precision in resource spending. Loch and Christoph (2000) demonstrated that a new market or new technology can be attacked by a task force led by R&D. Further, technological newness was related to a content of R&D in the products (Steenhuis & de Bruijn, 2006).

Therefore, we hypothesize that:

H6: Degree of product market and technological newness are positively related to R&D strategy.

2.4.2 .R&D Strategy and User Innovation

Steinhoff and Breuer (2009) introduced a systematic open R&D and innovation approach called user-driven innovation. Gambardella *et al*. (2015) designed a model of R&D strategy with user innovation activities, revealed that producers' optimal R&D strategies yield a suboptimal division of innovative labor between users and producers at the societal level.

Therefore, we hypothesize that:

H7a: R&D strategy is positively related to high level of user expertise.

H7b: R&D strategy is positively related to user innovation implementation.

2.4.3. R&D Strategy and NPD Project Success

A relatively high rate of NPD Project success is originated from marketing and customers as compared to ideas originating from R&D, suppliers, and managemen (Souder, 1987). Cooper and Kleinschmidt (1995) demonstrated the three cornerstones of NPD success; Process, Strategy and Resources. A successful NPD process meets market demands and needs with an appropriate R&D Strategy (Lu & Chang, 2002; Song & Thieme, 2006). Fain *et al*. (2011) based on the model developed by Gupta *et al*. (1986), conducted a Partial Least Squares (PLS) analysis on Slovenian companies with different NPD characteristics, and confirmed that NPD success is influenced by the level of R&D.

Therefore, we hypothesize that:

H8a: The efficiency of NPD project is positively affected by R&D strategy.

H8b: The effectiveness of NPD project is positively affected by R&D strategy.

3. Proposed Conceptual Model

According to the findings from the comprehensive review of existing reference in the literature of new product success and user innovation, a conceptual model has been designed as presented in Figure 2 includes the user innovation, contextual factors, R&D, and NPD project success. Thus, in the proposed model,user innovation is affected by contextual factors, R&D. In addition to the NPD project success is significantly affected by the impact of user innovation, contextual factors and R&D.

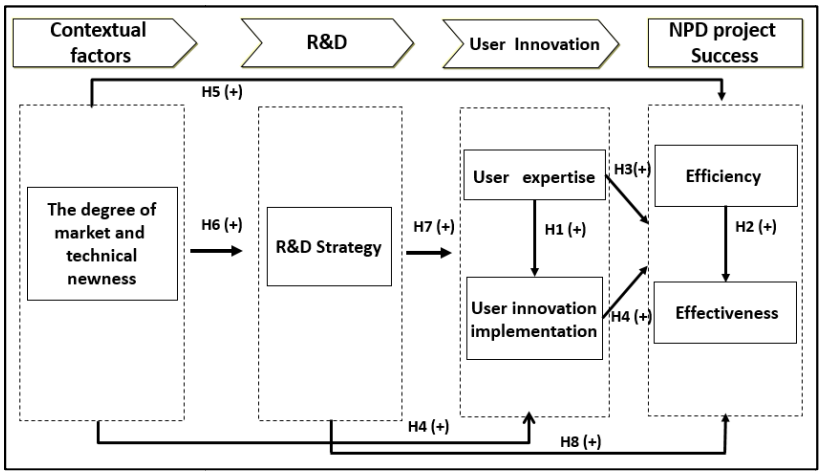

Figure 2: Conceptual model

4. Conclusion

Many studies have been conducted to identify new product success factors, but they did not pay any attention to the success of the efficiency and effectiveness of the NPD project that affected by the success of user innovation implementation. Moreover, little and most likely no previous study had tried to mention the dgree of product market, technological newness as the impact factor on new product success. Besides, there is a consensus among researchers that the R&D Strategy is one of the important factors of NPD success. Thus, based on the systematic literature reviews, it is possible to design the theoretical framework consist of contextual factors. Hence, these factors may help firms to focus and use the user innovation paradigm; also, these factors affect the relation of NPD success. This study is an attempt to provide a detailed analysis on the impact of user innovation on the success of NPD and this impact is moderated with three factors : Degree of product market, technological newness, R&D Strategy and, user expertise. This synthesis model may be used for better understanding of user innovation that contributes in explaining the NPD. Meanwhile, since the proposed framework is highly conceptual, and the constructs have been based on several literatures, thus, the framework had to be validated empirically through an empirical method for example, by means of interview and survey questionnaire. For future reaserch. We tend to conduct a survey by collecting data in Japanese firms, confirming the relationship between variables.

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