



# Front end of innovation of high technology industries: The moderating effect of front-end fuzziness

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## ABSTRACT

Effectively managing the front end of innovation (FEI) has become an essential element in the successful development of innovative products, thereby enhancing the sustainable competitive advantage of high-tech industry. In spite of researchers and practitioners' realization of the importance of FEI, owing to front-end fuzziness, it is not so easy to manage serious weaknesses in FEI. This study, in order to achieve improved FEI performance, creates a holistic FEI view and explores the impact of front-end fuzziness on situation factors, based on contingency theory. This study tested the hypotheses, using data collected from a survey of Taiwanese high-tech firms. The results support the hypothesis by showing that strategic goal, proficient procedure, and innovative culture relate positively in contributing to FEI performance, and, the moderating impact of front-end fuzziness on the relationship between dedicated team and FEI performance, as well as between proficient procedure and FEI performance, particularly in regard to technology fuzziness and competitor fuzziness. This pattern of results suggests that high-tech firms should emphasize FEI management under different fuzziness situations to foster continuous FEI performance improvement.

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## 1. Introduction

New product development (NPD) with high failure rates has often been related to the little effort put in during the front-end phases (Cooper, 2001; Dwyer & Mellor, 1991; Herstatt, Verworn, & Nagahira, 2004; Khurana & Rosenthal, 1998; Kim & Wilemon, 2002b; Ozer, 2007; Verganti, 1999; Verworn, 2009). The main objective of front-end activities is to provide strong product concepts that can be refined and developed during the NPD process (Elmqvist & Segrestin, 2007). Backman, Borjesson, and Setterberg (2007) indicate that the greatest opportunities for improving the overall innovation process lie in the front-end phases of NPD, with the so called “front end of innovation” (FEI) regarded as the most critical phase of the innovation process (Brem & Voigt, 2009; Poskela & Martinsuo, 2009). It is surprising that little research has been done on the issue thus far.

Researchers and practitioners realize the importance of FEI (Brem & Voigt, 2009; Dwyer & Mellor, 1991; Herstatt et al., 2004; Khurana & Rosenthal, 1998; Kim & Wilemon, 2002b; Ozer, 2007; Shenhar, Tishler, Dvir, Lipovetsky, & Lechler, 2002; Verworn, 2009; Verworn, Herstatt, & Nagahira, 2008), yet many practitioners also acknowledge a serious weakness in the FEI of their product innovation process (Khurana & Rosenthal, 1997; Kim & Wilemon, 2002b). Managing the front-end is not easy; the main reasons include: (1) features of FEI have fuzziness complexities, uncertainties and uncontrollable factors; (2) it is difficult to gather reliable information; and (3) as FEI is a dynamic process, it is often unstructured and exhibits low levels of formalization (Brem & Voigt, 2009; Herstatt et al., 2004; Khurana & Rosenthal, 1998; Kim & Wilemon, 2002b; Murphy & Kumar, 1997; Ozer, 2007).

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Effectively managing the FEI can enhance sustainable competitive (innovation) advantage, but innovation management is a difficult challenge for managers (Brem & Voigt, 2009; Kim & Wilemon, 2002b). During FEI, quality, costs, and timings have large opportunities to achieve improvements for time-to-market (Kim & Wilemon, 2002b; Smith & Reinertsen, 1998; Verworn et al., 2008). From a cost viewpoint, avoiding unrecoverable sunk costs and resource consumption is crucial if there is an immediate termination of a poor product concept leading to product development. FEI also is a stage where one can shorten development time and reduce delays (Murphy & Kumar, 1997). Many researches point out that effectively performing FEI can directly contribute to the success of a new product (Cooper, 2001; Dwyer & Mellor, 1991; Kim & Wilemon, 2002b).

The high-tech industry is very complex (Albors-Garrigos, Hervás-Oliver, & Hidalgo, 2009; Hoyt & Matuszek, 2001; Willoughby, 2004). The need for developing innovative products is incontestable; the ability to create novel product concepts has become an essential prerequisite for the long-term survival of high-tech industries (Elmquist & Segrestin, 2007). Cooper (2001) stresses the importance of both market-related and technical activities in the front-end. The high-tech industry has traditionally been primarily technology driven over the last decade; however, exterior design and internal product design features have increasingly been related to knowledge of the market and customer demands (Backman et al., 2007; Cooper, 2001). Front-end fuzziness has hampered product innovation success (Zhang & Doll, 2001); some authors argue that there are no front-end activities which are suitable for all situations (Elmquist & Segrestin, 2007), and this remains a neglected topic in the relevant literature on product development. Thus, in order to achieve improved FEI performance, this study creates a holistic FEI view and investigates the impact of different situational factors based on contingency theory, to help managers to more effectively manage front-end activities.

In the following sections, first, a brief review of the relevant FEI literature will be provided to highlight the importance of FEI and its performance. Following this discussion, a theoretical conception is introduced, incorporating crucial internal and external firm factors and their relation to performance. Next, a detailed description is provided of the methodology for testing a set of hypotheses derived from the theoretical conception. The paper concludes with a summary of the findings, followed by a discussion on the research implications.

## 2. Literature review and hypotheses development

### 2.1. Portraits of the FEI phase

The innovation process of NPD is divided into three stages: FEI, product development, and commercialization (Ozer, 2007; Zhang & Doll, 2001). During the FEI stage, an organization formulates a product concept and determines whether or not it should invest resources to develop the idea (Kim & Wilemon, 2002b; Moenaert, De Meyer, Souder, & Deschoolmeester, 1995). Innovation management comprises a systematic planning and controlling process which includes all of the relevant activities required to conceptualize and introduce innovative products to the development processes (Brem & Voigt, 2009). Thus, we define the FEI as a systematic planning and controlling process during the period between when an opportunity is first considered and when an idea is judged ready for innovative product development.

Some literature has clearly identified FEI activities as directly contributing to new product success (Cooper, 2001; Khurana & Rosenthal, 1998; Murphy & Kumar, 1997). Khurana and Rosenthal (1998) point out that FEI includes: product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews. Cooper (2001) identified idea generation, product definition and project evaluation as aspects of the predevelopment stages based on process development. Idea generation involves conceiving of the product idea. Product definition includes defining the product, its positioning, benefits and design. Finally, project evaluation includes assessments of the market, technical, manufacturing and financial viability of the product idea (Kim & Wilemon, 2002b; Murphy & Kumar, 1997).

### 2.2. FEI performance: efficiency and effectiveness

Many researches have confirmed the impact of FEI on the performance of NPD (Khurana & Rosenthal, 1998; Verworn, 2009; Verworn et al., 2008). Essential issues for FEI include how performance will be measured and its dimensions assessed (Kim & Wilemon, 2002a); yet, researches exploring FEI performance are very rare.

The majority of the literature focuses on improved cycle times for NPD (Murphy & Kumar, 1996). However, if there is a lack in any of the following: vision, perceived urgency, formalization, effective project leadership in FEI, even effective communication processes and effective people conducting the FEI work (Kim & Wilemon, 2002a,b; Rosenau, 1988), the results can lead to time delays, increased costs, lose launch opportunities, and the inability to achieve a competitive advantage.

Evaluation of FEI performance is a difficult, challenging task for managers. Since FEI performance is impossible to estimate by traditional measures, such as certain scope, time, cost and profit are yet to be fixed (Poskela & Martinsuo, 2009). The majority of the literature on NPD performance has observable targets, but proper FEI contributes to achieving a superior, validated product concept based on its exploratory nature (Kim & Wilemon, 2002a; Poskela & Martinsuo, 2009).

FEI performance has been measured in some academic researches by its efficiency and effectiveness (Chen, Chang, & Lin, 2010; Verworn et al., 2008; Wagner, 2010). Efficiency means doing things right, with the focus on the process or “means”. From a process viewpoint, the efficiency of FEI performance is based on doing something with the least possible expenditure of resources (such as time, cost, etc.). Effectiveness refers to doing the right things, with the focus on the end result. From the outcome viewpoint, the

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