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Risk management on joint product development with power asymmetry between supplier and manufacturer

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Abstract

Risk management is a critical issue in complex product development, especially when suppliers are integrated. The power asymmetry between the supplier and manufacturer may largely influence the development process and affect the occurrence and interaction of risks, and it should be systematically examined. In this paper, we establish a structural model to study the impact of power asymmetry on risk occurrence in the joint product development (JPD). Empirical data collected from engineers in airspace industries show that path coefficients of the risk structural model are significantly different between the manufacturer-advantaged situation and the supplier-advantaged situation. The results indicate that power asymmetry has significant effects on risk occurrence and interaction. Furthermore, we provide managerial insights into customized risk-reduction measures from the perspective of the discovered relationship difference.

Keywords: Risk management; Joint product development; Supplier involvement; Power asymmetry; Partial least squares

1. Introduction

Market competitions have placed an enormous amount of pressure on firms and pushed them to seek advantage by developing new products (Ernst and Fischer, 2014). Because the process of product development (PD) is characterized as "innovative, creative and iterative" (Browning and Eppinger, 2002) and complex (Browning, 1998; Kardes et al., 2013), it proposes new challenges for product managers and engineers. For instance, because of a series of technical uncertainties, the delivery of the Boeing 787 Dreamliner aircraft was delayed for more than three years and was billions of dollars over budget (Denning, 2013; Kardes et al., 2013). Similar cases are reported frequently in the development of other products such as software (Oehmen et al., 2014), automobiles, semiconductors (Osborne, 1993) and warfighters (Kardes et al., 2013). Therefore, risk management plays a key role in enabling the success of product development.

According to PMBOK Guide (Project Management Institute, 2013), project risk is "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, or quality." Therefore a risk has two components: the uncertainty of an event (measured by probability) and the potential impact of the event on the project. In other words, uncertainties can be traced to the source of risks (Browning, 1999). Based on the uncertainty and the impact, risk managers can assess the amount efforts that need to be reserved to handle the risk. Risk management can be described as the process of risk analysis in the product development at the conceptual, preliminary and detail design stages, with respect to risk prediction, assessment and evaluation (Stapelberg, 2009). In product development projects, the activities of managing risks can be interpreted as a structured reduction of uncertainties (Oehmen et al., 2014).

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However, reducing product development uncertainties is difficult due to the following barriers: product complexity, collaborative development, supplier involvement and power dependence (Browning, 1998; Gulati and Sytch, 2007; Li et al., 2014; Wasti and Liker, 1997). Prior studies suggested that firms tended to break the complex product into subsystems and outsourced the design work to external suppliers (Denning, 2013). This joint development model forced the buyer to assume the role of original equipment manufacturer (OEM), which was popular for Boeing, Airbus and other aircraft manufacturers because OEMs and suppliers could share benefits and risks (Esposito and Passaro, 2009). However, uncertainties arose with the involvement of external suppliers because of the apparent difficulty in communication, coordination, and knowledge sharing between the developers and because risk management would become tough and special (Kardes et al., 2013; Li et al., 2014; McIvor and Humphreys, 2004; Wynstra and Pierick, 2000). Moreover, the manufacturer with outsourcing capabilities would depend on the supplier's technical strength and project experience or vice versa, considerably increasing dependence uncertainties (Gulati and Sytch, 2007). This mutual dependence can be deemed as a power, which is a scarce resource that organizations compete for, and its constructs strongly influence the decision-making process (Caniels and Roeleveld, 2009). Gulati and Sytch (2007) reported that auto manufacturers would exploit weaker suppliers to obtain superior economic returns in the automotive industry. It might be easier for the advantaged side to identify and avoid risks; however, the disadvantage for its counterpart may increase the probability of risk occurrence.

Therefore, it is vital to understand how the power asymmetry between manufacturers and suppliers would affect the risk occurrences in JPD. Since it has not been revealed in previous literature, we devote to answer this question in this study. The work would enlighten the managers and engineers to adjust their supplier selection and risk management strategies in terms of power asymmetry and take targeted risk-reduction measures correspondingly during JPD projects. To demonstrate this viewpoint, we developed a structural model that described such causes-risks relationship from the perspective of supplier involvement. Then, we collected data and analyzed the difference between different power asymmetry situations. The rest of the paper is organized as follows. Section 2 provides the fundamental literature support to construct the risk model, and Section 3 describes the methodologies of our study. Section 4 constructs the model. It is followed by Section 5, which gives the statistical results of the empirical research. The results are then discussed in Section 6, and some insightful implications are drawn in Section 7 to conclude the paper.

2. Theoretical foundations

2.1. Feature of product development

The PD process can be described as a complex network of interaction, some of which is based on the input from other parts or some of which precipitates a cascade of rework among activities (Browning and Eppinger, 2002). Factors that contribute to the complexity of product development consist of a long-term development cycle, the participation of numerous partners and contractors from multiple countries, the fluid nature of technologies deployed and the dynamism of external environments (Kardes et al., 2013).

The JPD projects are also characterized by complexity, uncertainty, ambiguity, dynamic interfaces and time periods reaching a decade or more (Floricel and Miller, 2001; Kardes et al., 2013). Miller and Lessard (2001) said, *large engineering projects are high stake games characterized by substantial irreversible commitments, skewed reward structures in case of success, and high probabilities of failure.* These difficulties and obstacles drive manufacturers to include suppliers into product development during the initial phase. For example, complex products, such as aircrafts, usually involve a necessary degree of outsourcing from suppliers simply because the manufacturers lack the necessary expertise in some areas, e.g., engines and avionics (Tang et al., 2009). Given the underlying complexity of new product development, it is not surprising that different types of intelligence and organizations are necessary for its success (Thomas, 2013).

2.2. Joint development by involving suppliers

Over the past decades, there have been extensive studies on integrating suppliers in the JPD process (Handfield et al., 1999; Van Echtelt et al., 2008). Scholars suggested that to construct an early and close relationship with suppliers was critical for manufacturers to succeed in JPD (Cousins et al., 2011; Najafi-Tavani et al., 2013). Early supplier involvement signified the utilization of joint capabilities to solve tough problems during the development process (Wagner and Hoegl, 2006). Collaboration with suppliers at the product design stage reduced the occurrence of design errors and also provided benefits to the testing and prototyping phases by sharing technical information early (Song and Di Benedetto, 2008). It enabled the manufacturers to shorten the development cycle, to increase the quality of new product launches and to introduce richer technologies into a new product (De Toni, 1999; Najafi-Tavani et al., 2013; Zsidisin and Smith, 2005).

However, empirical studies also found negative effects for supplier involvement in JPD (Thomas, 2013). A supplier's involvement may not always lead to improvements in efficiency (cost and time) and effectiveness (cost and quality), especially in an environment that undergoes significant changes or where a high degree of technical uncertainties exist (McIvor and Humphreys, 2004; Wynstra and Pierick, 2000). Hong and Hartley (2011) showed that encouraging suppliers to communicate did not have any effect on product development performance. Specifically, if the manufacturer cannot have direct control over the progress of technology, technical risk will increase. Moreover, the suppliers' early involvement into product development would increase the manufacturers' dependence and reliance on suppliers because the switching cost and technologies were highly restricted by the advantaged suppliers (Caniels and Roeleveld, 2009).