# International R&D partnerships and intrafirm R&D-marketing-production integration of manufacturing firms in emerging economies

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## Abstract

Although cross-functional integration is important for research and development (R&D), research about implications of cross-functional integration has been rather sparse. In new product development (NPD), no study to date has examined intrafirm as well as interfirm integration of key functions such as intrafirm R&D-marketing-production together with interfirm integration of host R&D-partner R&D. Such marketing and operations interface contributes to a better understanding of how operational and marketing activities impact on competitiveness and firm performance. This study collected data from 202 electronics manufacturing firms operating in an emerging economy, mainland China and Hong Kong with international R&D partnerships. The findings indicate that a high level of R&D integration between firms improved NPD performance when cross-functional integration is based on existing rather than new product configurations and key technologies. Interestingly, in high distance situations, cross-functional integration in the production validation stage generated NPD success. The findings show that high environmental uncertainties lead to a high level of host and partner firms R&D integration. However, product newness has no significant effects on R&D integration in any of the NPD stages.

*Keywords:* NPD collaboration, Environmental uncertainty, Product newness, R&D partners distance, R&D experience.

*Research Highlights*:

- We address a key interface of operations and marketing in intra- and interfirm integration of functions for NPD.
- We examine R&D integration between host and partner collaboration.

- Changing situational dimensions influences cross-functional integration and new product performance.
- Varying the levels of integration across functions in intrafirm and interfirm R&D alliances can enhance NPD performance.

## 1. Introduction

In today’s globalized markets, one of the ways firms respond to competitive pressures is by developing international research and development (R&D) partnerships, and strengthening cross-functional integration (Song, Thieme, & Xie, 1998; Van Dierdonck & Miller, 1980). In particular, firms in emerging markets increasingly form R&D partnerships with foreign firms to compete with established global firms and gain new knowledge such as new technologies and digitized product development processes. With rapid proliferation of new product offerings, fast changing environments and shortened product life cycles, knowledge of how integration of key functions and stages of new product development (NPD) in intra and interfirm integration affect successful operations will determine a firm’s long-term competitiveness (Verona, 1999; Holland, Gaston, & Gomes, 2000; Koufteros et al., 2002). Operations research shows the importance of cross-functional integration among organizational functions in determining new product performance (e.g., Harryson, 1997; Ernst, Hoyer, & Rübsaamen, 2010). As global competition intensifies, it is imperative for firms operating in emerging economies (China, Brazil and India) to improve operational efficiency of functional interdependence in intra and interfirm R&D partnerships. Cross-functional integration can help firms not only generate innovation but also reduce inefficiency of information asymmetry as a result of resource and/or activity duplications among functions and between firms. Yet, no research has examined the impact of both intra and interfirm integration activities on NPD performance.

Previous studies mainly examined intra-firm interaction and collaboration among functions, e.g., marketing, logistics, R&D, finance and manufacturing (e.g., Joshi, 2010, Kahn, & Mentzer, 1994; Maltz & Kohli, 2000). However, it is important to examine intrafirm integration across functions such as R&D-marketing-production together with interfirm integration of host R&D-partner R&D’ (hereafter R&D-R&D’) because interfirm NPD collaboration can be affected by intrafirm cross-functional integration (e.g., marketing-manufacturing, R&D-marketing). Consideration of both intra and interfirm integration can provide new insights into functional interdependence and new product performance success from operational as well as industrial marketing perspectives. For instance, operational demands of cross-functional activities combined with marketing's emphases such as environmental situations or situational dimensions would provide a more complete picture than separate treatment of either field of study or intra and interfirm functional integration. In NPD literature, situational dimensions include product newness, physical distance, R&D experience and environmental uncertainty (Griffin & Hauser, 1996; Song & Parry, 1997; Song et al., 1998; Olson, Walker Jr., & Ruekert, 2001; Jin, 2001; Lu & Yang, 2004). Since differing situational dimensions would have different degrees of impact on different types of cross-functional integration and NPD stages, it is important to understand appropriate levels of functional integration especially for an interfirm NPD collaboration spanning diverse geographical boundaries and market environments. Despite the increasing dominance of major emerging economies in global manufacturing, no research has yet examined the above gaps. Thus, in the context of China, the present study examines: (1) whether more host R&D-partner R&D' integration during the NPD process result in better NPD performance; (2) how R&D integration across firms generate NPD success under different situational dimensions; and (3) how R&D-marketing-production integration within firm generates NPD success under different situational dimensions.

## 2. Theory and Hypotheses

Cross-functional integration can be defined as operational collaboration among intra and/or interfirm functions such as NPD collaboration in terms of information sharing and cooperation involving resources across functions (e.g., Song & Parry, 1992, 1993; Gupta, Raj, & Wilemon, 1985a & b, 1986; Song et al., 1998). Functional integration has been mainly examined through resource dependency theory (Pfeffer & Salancik, 1978) and contingency theory (Lenz, 1980, 1981; Miller, 1988; Venkatraman, 1989). In terms of resource dependency theory, interdependency exists among coalitions for critical resources, in this case between functions. For example, a cross-functional team comprises individuals from different functions to apply different skills to achieve common organizational objectives such as common goals in collaborative NPD (Holland et al., 2000). Resource dependency theory posits that interdependency of resources and capabilities through integration enables firms to better cope with their environment (Ettlie, 1995; Swink, 1999). Put simply, each firm in NPD partnerships or each function in collaborative NPD shares and integrates critical resources to successfully achieve common NPD objectives. However, the extent of interdependence particularly at different NPD stages may differ in terms of internal and external resource differences and demands. For example, R&D, marketing, and production functions in an organization have different priorities and educational backgrounds, which may influence the outcome of their integration. Individual functions develop distinct skills, resources, and professional capabilities which are interdependent across organizational functions (Ruekert & Walker, 1987; Verona, 1999; Song & Swink, 2002; O'Leary-Kelly & Flores, 2002; Sherman, Berkowitz, & Souder, 2005). Thus, firms that integrate intra and/or interfirm functions would have a better control over external jolts in the environment through shared and integrated resources (Pfeffer & Salancik, 1978).

A contingency theory suggests that cross-functional integration among different departments represents an important aspect of organizational structure in terms of the types of lateral relationships, and the degree of collaboration and participation that exists between the different functions (Galbraith, 1973; Khandwalla, 1973). This is because empirical evidence shows that the relationship between functional integration and organizational performance is moderated by a firm's strategy and environment (O'Leary-Kelly & Flores, 2002). As such, the relevant contingency effects can lead to different levels of integration that affect NPD performance. Many firms are examining their product development practices and are implementing approaches such as cross-functional integration that enable them to cope with increasing uncertainty and equivocality (Koufteros et al., 2002). A contingency perspective contends that improvement in NPD performance is not simply achieved by increasing the level of integration under all circumstances, but could be contingent upon different situations (Yap & Souder, 1994; Song et al., 1998; Sherman et al., 2005). For example, new products are susceptible to a high environmental uncertainty (Huber, O'Connell, & Cummings, 1975) and increased integration may not always be beneficial to overall performance (Adler, 1995). Previous studies have shown that the relationship between cross-functional integration and NPD performance is moderated by certain situational dimensions, e.g., product newness (Jin, 2001; Song & Swink, 2002), company characteristics (Thieme, Song, & Shin, 2003; Lu & Yang, 2004), and environmental uncertainties (Song & Montoya-Weiss, 2001; Lu & Yang, 2004); and in further specific relationships between cross-functional integration in each NPD stage and NPD performance (e.g. Song et al., 1998; Olson, 2001; Song & Swink, 2002; Lu & Yang, 2004). Thus, emerging economy contexts such as international R&D partnerships in China may influence situational dimensions and their effects on the specific cross-functional integration and NPD performance.

< Take in **Table 1: Common NPD Process in China's electronics and/or high-technology manufacturing industry>**

It is possible to delineate four distinct NPD stages in China's high-tech industries: the initial stage, the engineering validation test (EVT), the design validation test (DVT) stage, and the production validation test (PVT) (see Table 1). Although NPD process of manufacturing industries in industrialized countries has been divided into five stages with development, test and pilot run as a separate stage (e.g., Lu, 2003; Lu & Yang, 2004), intense competition and lack of long-term R&D projects in emerging countries necessitate rapid production test to capture market demands early as opposed to implementing pilot run.

<Take in **Table 2: A Review of Research on Cross-Functional Integration**>

In a review of past studies on the integration of production and marketing/sales decisions, O'Leary-Kelly and Flores (2002) note that few empirical studies focused on the integration of decision areas involving the production-marketing interface. Although prior research examined functional integration of R&D-marketing, and production-marketing (e.g., Van Dierdonck & Miller, 1980; Song & Swink, 2002), research on the interface of host R&D-partner R&D' (R&D-R&D') in NPD under different situational dimensions has been rather sparse (see Table 2). As the relative importance of each functional specialist's role such as R&D can be interdependent and different between firms (Olson et al., 2001; Jin, 2001; Verma & Sinha, 2002), R&D partnerships and integration with other specialist functions such as marketing and production may affect NPD performance. Empirical evidence shows that integration between partners in NPD collaboration can affect NPD performance (e.g. Sivadas & Dwyer, 2000; Lichtenthaler & Lichtenthaler, 2004; Ettlie & Pavlou, 2006).

In the R&D-marketing interface, different R&D projects (situational dimensions) require different actions being taken (structural / process dimensions), which in turn affect firm performance (e.g., Ruekert & Walker, 1987). Prior research on the types and levels of cross-functional integration in each NPD stage produced inconclusive results in terms of variation of the influence of situational dimensions on the stages of NPD process. Brettel et al. (2011), Swink and Song (2007), Gomes et al. (2003), Song and Swink (2002), Olson et al. (2001) and Song et al. (1998) have found both the same as well as conflicting results for the integration of NPD stages across functions. In a survey of 236 managers from a variety of industries against five stages of NPD process, Song et al. (1998) have shown the impact of joint involvement between divisions on NPD performance may be positive, not significant, or even negative depending each NPD stage. Olson et al. (2001) have arrived at relatively similar conclusions from their survey of 34 projects in a diverse array of industries, and examined the impact of the level of cooperation between functions on NPD performance in two NPD stages—the early stage for product conceptualization and the later stage for physical production. Brettel et als' (2011) survey of 118 NPD projects shows varying performance implications of diverse types of cross-functional integration in two NPD stages—the development and commercialisation stages. Similar results were also observed in Swink and Song (2007) and Song and Swink's (2002) studies which examined the effect of cross-functional integration across four NPD stages, and Gomes et als' (2003) research which examined the integration based on five NPD stages.

Some studies support early NPD involvement in marketing-production, R&D-production in later NPD stages and R&D-marketing in all NPD stages. In contrast, there is little consensus about the integration of marketing-production in later NPD stages and R&D-production in early NPD stages. Various studies have found different patterns and effects of R&D-marketing, R&D-production, or marketing-production integration under different situational dimensions (e.g. Souder, Sherman, & Davis-Cooper, 1998; Olson et al., 2001; Thieme et al., 2003; Lu & Yang, 2004; O'Leary-Kelly & Flores, 2002; Koufteros et al., 2002). One possible explanation for the lack of consensus could be due to contextual differences in a variety of industries or a portfolio of selected industries and inconsistent comparisons of NPD stages. In this instance, while Swink and Song (2007) focus on business analysis, technical development, product testing and product commercialisation stages of NPD process, Gomes et al.'s (2003) research uses entirely different stages (or terminologies) of NPD process such as concept generation and post-commercialisation. In a further contrast, Olson et als' study (2001) only focuses on early and later NPD stages by classifying the development, test, and mass production stages as one stage. Thus, by examining the integration of R&D partnerships (i.e., R&D-R&D’) against the influence of high or low situational dimensions along four different NPD stages, this study adds to the body of knowledge about R&D partnerships, and extends prior research on R&D-marketing (Verma & Sinha, 2002; Song & Thieme, 2006), and manufacturing (production)-marketing interface (e.g., Ruekert & Walker, 1987; Hausman, Montgomery, & Roth., 2002; O’Leary-Kelly & Flores, 2002). The conceptual framework of this study is depicted in Figure 1.

<Take in **Figure 1: Conceptual Framework**>

### *2.1. Situational dimensions*

#### *2.1.1. The effect of situational dimensions on the degree of interfirm R&D and intrafirm R&D-marketing-production integration*

It is likely that R&D personnel possess fewer relevant experiences in environment situations of high product newness because of path dependence in the long-term nature R&D investment (Jin, 2001). In NPD project coordination, the newer the product is to at least one partner, the less familiar it is to the R&D personnel, resulting in greater interaction and information exchange, i.e. integration between the partners. At the firm level, the physical distance between functions has been found to be a significant barrier to cooperation. A high distance between functions diminishes the communication between functions sharply, and the quantity and quality of information exchanges in both formal and informal interactions (Griffin & Hauser, 1996; Song, Neeley, & Zhao, 1996; Allen, 1997; Lu & Yang, 2004). Distance can be a major barrier in international R&D partnerships with partners from different companies based in different countries. Although the distance between partners increases the difficulty of interactions, it may also become a motivation for the partners to cooperate more with each other. Distance includes not only geographical, but also cultural, economical, and administrative distance (Ghemawat, 2001). For example, distance based on cultural differences has been examined as national, organizational and professional cultural differences (Sirmon & Lane, 2004).

In the initial stage of product development, R&D partners focus on generating new product ideas. International R&D partners have better access to external knowledge from exposure to complementary skills, novel ideas and new technologies than domestic R&D partnerships (Rosenkopf & Almeida, 2003). This can help firms to produce highly innovative product ideas by exploring and exploiting new knowledge for NPD. Previous research shows that firms can access external knowledge through intra-industry and inter-industry alliances (Katila, 2002). Partnerships at the inter-industry level generate more innovative ideas and creative outputs than intra-industry alliances (Kotabe & Swan, 1995). In international markets, an existing product in one market can represent a new product idea in another market. As such, the distance of international R&D partners requires a high degree of interfirm R&D integration especially for incorporating a high degree of product newness.

Since one of the main objectives of later NPD stages (EVT, DVT and PVT) is to achieve rapid commercialization by ensuring a product is adequately tested for mass production, integration between R&D partners is especially critical for a high degree of product newness to reduce an equally high degree of uncertainty. In particular, R&D partners that integrate early in the engineering and design validation process can eliminate delay time to market by reducing potential occurrence of technical problems in later NPD stages (Olson, Walker Jr., & Ruekert, 1995; Sherman, Souder, & Jenssen, 2000). Moreover, it can be argued R&D personnel are in a better position to resolve unexpected problems for a high degree of product newness than production personnel. Thus, it can be hypothesized that:

*Hypothesis 1:* Product newness will be positively related to the attained level of R&D-R&D' integration in all NPD stages (i.e. initial, EVT, DVT, PVT).

*Hypothesis 2:* The distance between two R&D partners will be positively related to the attained level of R&D-R&D' integration in all NPD stages (i.e. initial, EVT, DVT, PVT).

The environmental uncertainty dimension comprises technical uncertainty and market uncertainty (Boyd, Dess, & Rasheed, 1993). Technical uncertainty includes technological evolution, technology discontinuities, and a lack of knowledge about exact means to accomplish a project (Tushman & Rosenkopf, 1992; Tatikonda & Montoya-Weiss, 2001). Market uncertainty assesses a firm's familiarity with a market, understanding of customers' needs (Souder & Song, 1997), and comprehension of competitors' strategies. Firms will face a high level of difficulties in assessing the implications of their present and future actions in a very uncertain technical and market situations.

In a high environmental uncertainty, the role of cross-functional integration in NPD is more important than a low environmental uncertainty (Souder et al., 1998). This is because of a greater need of firms in highly uncertain environments than low environmental uncertainty for interdependency across functional units to share information, integrate expertise and use other firms' resources (Olson et al. 2011). Similarly, firms would be more conservative in their allocation of scarce and critical internal resources (Souder & Moneart, 1992; Pfeffer & Salancik, 1973). Firms would avoid using critical internal resources to make huge investments but prefer to share risks in interfirm cross-functional integration. This is prevalent in biotechnology and electronic industries characterized by high levels of environmental uncertainty such as rapidly changing technologies (Bucklin & Sengupta, 1993). Interfirm R&D integration would help firms to cope with turbulent markets and better able to serve changing customers in a timely manner. Thus, firms in interfirm R&D

integration will tend to use the R&D experience, technical expertise and resources of their partners to enhance NPD performance under high environmental uncertainty situations. Accordingly:

*Hypothesis 3*: The environmental uncertainty between two R&D partners will be positively related to the attained level of R&D-R&D' integration in all NPD stages (i.e. initial, EVT, DVT, PVT).

*Hypothesis 4:* The R&D experience of the two R&D partners will be positively related to their attained level of R&D-R&D' integration in all NPD stages (i.e. initial, EVT, DVT, PVT).

### *2.1.2. The effect of situational dimensions on the success of interfirm R&D-marketing-production integration*

It is argued that integration of R&D-R&D' and R&D-marketing-production against four NPD stages (Initial, EVT, DVT, PVT) would lead to different NPD outcomes depending on the situational dimensions. Olson et al. (2001) have studied the moderating effect of project innovativeness on the relationship between cooperation patterns and NPD performance. They have examined marketing-production interface and their findings indicate that it is best to allow R&D and marketing determine together the market's needs and the basic technology requirements in the early NPD stages of highly innovative projects. Song and Swink (2002) have examined the relationship between marketing-production integration against four NPD stages and their impact on NPD performance for radical and incremental projects by analyzing 467 high-tech projects. They have found that integration efforts in the early and commercialization stages are less effective on NPD performance compared to other stages of radical projects in contrast to the result of incremental projects. In testing R&D-marketing-manufacturing integration, Brettel et al. (2011) have observed the moderating effect of project innovativeness on NPD outcomes in terms of efficiency but not effectiveness, which has diminished significance from incremental to radical NPD projects. In other words, R&D-marketing and R&D-manufacturing integration of radical innovation have a positive influence on project efficiency only in the commercialization stage but not in the development stage. Gomes et al. (2003) have found that interaction may be beneficial for less innovative new products while collaboration may be necessary when developing highly new products.

As noted previously, R&D-marketing-production integration is vital for generating NPD success at early NPD stages process to avoid cost-utility maximization problems later in the production process particularly for high product newness situations. At the PVT phase, R&D-production integration can be used to identify modular technical designs to fine-tune the production process. The integration of R&D and marketing can help reduce conflicts of unrealistic production expectations, which may delay development time of new products (Calantone, Droge, & Vickery, 2002). In addition, R&D-marketing integration at early NPD stages reduces costly redesign with a better understanding of operational designs against industrial markets. In addition, interfirm R&D integration motivates the partner firms to work collaboratively in the initial NPD stages as well as enables the integration of complementary assets and competencies to develop and commercialize new products (Rothaermel & Deeds, 2004). The role of cross-functional integration is not limited to R&D. For example, production-marketing integration can reveal whether a particular pricing strategy (e.g. low price) allows for sufficient margin to cover the subsequent production costs (Kahn & McDonough, 1997). By and large cross-functional integration increases NPD performance such as speed-to-market and quality of the end product through core competencies of other firms. Thus, it can be hypothesized that:

*Hypothesis 5:* In high product newness situations, the patterns of cross-functional integration will positively influence NPD performance for R&D-R&D’ integration in all NPD stages (i.e. initial, EVT, DVT, PVT).

*Hypothesis 6*: In high product newness situations, the patterns of cross-functional integration will positively influence NPD performance for R&D-Marketing-Production integration in the initial and PVT stages.

Physical distance between project team members has been shown as one of the key reasons for reducing the quality and quantity of communication and information exchange. The lack of face-to-face communication due to the physical isolation has been suggested to delay decision-making and lengthen the NPD process (Sherman et al., 2000; Griffin & Hauser, 1996). However, recent research has demonstrated that face-to-face communication has little effect on enhanced NPD performance. In contrast, it has shown that non face-to-face communication forms, such as email communication, leads to both improved product creativity and product development speed (Ganesan, Malter, & Rindfleisch, 2005). As the partner R&D` team only directly communicates with the host R&D team, not the marketing and production divisions, the distance between R&D partners may have minimal direct impacts on the integration of other focal functions. The patterns of the integration between R&D-marketing-production during the NPD process are expected to be consistent with both Song et al. (1998) and Olson et al.’s (2001) findings. Thus, it can be hypothesized that:

*Hypothesis 7:* In high partner distance situations, the patterns of cross-functional integration will positively influence NPD performance for R&D-R&D’ in all NPD stages (i.e. initial, EVT, DVT, PVT).

*Hypothesis 8*: In high partner distance situations, the patterns of cross-functional integration will positively influence NPD performance for R&D-marketing-production' integration in the initial and PVT stages.

Most prior research suggests that NPD success in highly uncertain environments can only be achieved by greater R&D-marketing-production integration (O'Leary-Kelly & Flores, 2002; Gupta, Raj, & Wilemon, 1986; Song & Montoya-Weiss, 2001; Fernandez, Del Rio, Varela, & Bande, 2010). However, there are also some contradictory views in that under uncertain environments where time to market is highly significant, cross-functional integration can become a burden to the parties involved (Souder et al., 1998). Griffin and Hauser (1996) and Song et al. (1996) state that barriers to cross-functional integration can arise due to several reasons such as different personalities, ideologies, goal orientations, cultures, languages and communication modes, and organizational responsibilities of diverse functional units. In the context of interfirm R&D integration, differences in organizational cultures, orientations and goals can represent a significant barrier to cooperation. These contradictions increase the significance of the discussion on whether the effectiveness of integration mechanisms is contingent upon the stage of development and the type of information that is most strongly needed (Souder & Moenaert, 1992). For instance, Souder et al. (1998) examine the interplay between uncertainty, integration, and NPD effectiveness by examining 101 NPD projects from US and UK high-tech firms. They note that under high technology uncertainty, firms should pay extra attention to prototype development proficiency, while under high market uncertainty, attention should be focused on improving product launch proficiency and market forecast accuracy. Souder and Moenaert (1992) and Khanna et al. (1998) have argued that it is necessary for a firm to reduce the negative impact of environmental uncertainty to sustain its competitive advantages. In a highly uncertain environment, the R&D partners are expected to have more frequent contact with each other for information exchange. Similarly, it is likely that R&D-marketing-production integration within a company is more intensive under high environmental turbulent or uncertain situations. Given the unique capabilities of diverse functional units, the integration across R&D, marketing and production units will be an inevitable consequence of adapting to dynamically changing and uncertain market environments (e.g., Koufteros et al., 2002). Thus, it can be hypothesized that:

*Hypothesis 9:* In high environmental uncertainty, the patterns of cross-functional integration will positively influence NPD performance for R&D-R&D' integration in all NPD stages (i.e. initial, EVT, DVT, PVT).

*Hypothesis 10*: In high environmental uncertainty, the patterns of cross-functional integration will positively influence NPD performance for R&D-marketing-production's integration in the initial and PVT stages.

Extant research has shown that R&D projects often deviate from planned objectives such as unit cost, project cost, time-to-market and product reliability objectives (Dougherty, 1996; Tatikonda & Rosenthal, 2000; Verma & Sinha, 2002). It is clear that R&D experience can be crucial for NPD success especially for interfirm R&D collaboration. Although studies on NPD alliances stress the importance of experience for NPD success through prior knowledge about technology and markets, (e.g., Bidault & Cummings, 1994; Link & Bauer, 1989; Rindfleisch & Moorman, 2001), no study has yet examined interfirm R&D experience in terms of its effects on different NPD stages in cross-functional integration between functions. In the strategic management literature, alliance experience has been shown to help firms develop alliance capability and enhance alliance success (Lyles, 1988; Simonin, 1997; Anand & Khanna, 2000; Kale & Singh, 2007). This suggests that R&D experience guides partners toward common NPD performance objectives through prior knowledge and experience on a variety of R&D integration issues such as drafting legal requirements, technology integration process, joint research knowledge, etc. A high level of R&D experience in NPD between firms can give partnering firms greater flexibility in managing different NPD stages based on past achievements. In manufacturing contexts, a firm with a high level of R&D experience can improve its innovativeness based on prior knowledge of established routines to exploit and develop new opportunities. Furthermore, prior knowledge and experience of expectations and challenges in different NPD stages can help R&D-R&D' collaboration increase NPD success such as speed-to-market, efficient coordination and prior knowledge of the sequence of NPD stages. Thus, it can be hypothesized that:

*Hypothesis 11*: In high R&D experience situations, the patterns of cross-functional integration will positively influence NPD performance for R&D-R&D' integration in all NPD stages (i.e., initial, EVT, DVT, PVT).

*Hypothesis 12*: In high R&D experience situations, the patterns of cross-functional integration will positively influence NPD performance for R&D-marketing-production's integration in the initial and PVT stages.

## 3. Methodology

### *3.1. Research context and data collection*

In the context of China's electronics manufacturing firms based in the Pearl River Delta, to a large extent their success depends on a high intensity of manufacturing activity, and interfirm NPD alliances (Eng & Spickett-Jones, 2009). Since the liberalization of the Chinese economy, local Chinese firms have increasingly engaged in foreign R&D partnerships to increase NPD and/or innovation performance. Such R&D partnerships are often motivated by the objective of collaboration to acquire technological knowledge and develop intellectual assets compared to typical collaborative arrangements of manufacturing firms in the United States based mainly on mutual risk reduction (ITIS, 2007). China's electronics manufacturing sectors have been a major contributor to the country's gross domestic product. As one of the largest markets in the world, China has been strategic for manufacturing bases of large local manufacturers and many foreign multinationals. Most Chinese manufacturers are OEM (Original Equipment Manufacturing) and/or ODM (Original Design Manufacturing) rather than OBM (Original Brand Manufacturing), which rely on access to large markets and cost advantages from large labor markets (Eng, 2009). In the context of NPD process, China's manufacturers would engage more in the testing, and design and development, and production stages than mass production and commercialization stages of NPD (see Table 1).

The sampling frame comprised the official China Business Directory and Hong Kong Business Directory focusing on independent manufacturers at headquarters level, i.e., non-subsidiaries or branches. The Hong Kong Economic and Trade Association (HKETA) provided help in randomly selecting 1100 mainland China and Hong Kong manufacturers located in major industrial cities within the electronics manufacturing industry. In particular, only manufacturers engaged in foreign R&D collaboration or with overseas firms to develop new products or technologies were considered. The target respondents for the study were project leaders, project managers, senior engineers and engineers meeting the following criteria (R&D partnerships): (1) target respondents have five years or more experience of product development, international R&D, international project collaboration and/or project management; (2) the manufacturer has R&D, marketing and production divisions; and (3) the manufacturer either has international R&D partners or in production collaboration with international partners outside China. The final sampling frame of the study consisted of 731 firms. The study targeted two key informants for each firm to reduce the threat of common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). A comparison of the results of independent variables (cross-functional integration between functions) against the dependent variable of NPD performance from the two key informants indicates a relatively strong correlation of $r = .53$, $p < .01$ and thus, the common method variance is not a threat.

The data collection exercise was implemented using a survey questionnaire designed to meet the objectives of this study. After a pilot test of the questionnaire which involved 21 manufacturers and two academic peers, the number of questions was reduced from 108 survey items to 75 survey items. The items were deleted and/or modified to increase relevance for the study after careful consideration of the feedback. In addition, the initial version was too long and respondents were unwilling to fully complete the questionnaire. The questionnaire was translated into Chinese (Mandarin) following the back translation procedure into English to ensure accuracy (Brislin, 1970).

The study used both postal mail survey and electronic email to known email addresses of the target firms to increase response rate. The postal mail survey generated 264 (132) usable responses and the email survey gathered 140 (70) usable responses after eliminating 23 sets of incomplete questionnaires. The overall number of usable responses was 202 complete cases or approximately 27 percent response rate. In order to increase response rate, the study employed a research assistant to contact respondents and gain cooperation through local business associations. The total response was obtained after two waves of mailing with an interval of three weeks for non-respondents. No significant difference was found after comparing the demographic profile of manufacturer size, location and industry sectors between early and late respondents. Of the total 202 manufacturers, 78 were from electronics and computer sales, 65 from industrial and consumer electronics and 59 from telecommunications. The majority of manufacturers were small or medium in size (78%) with fewer than 500 employees and annual revenues ranging from USD$8million to USD$122million.

Multiple-item measures were used in all the constructs anchored on a five-point Likert scale, ranging from “strongly disagree” (1) to “strongly agree” (5) except for two questions based on categorical answers. Please refer to Table 5 for a summary of the measurement scale items and their sources. Most of the scale items for the constructs were validated in previous studies except for the R&D partner distance construct, which has been adapted for the purpose of this study.

### *3.2. Measure reliability and validity*

<Take in **Table 3: Correlation Matrix**>

Prior to testing the hypotheses, reliability and validity of the measures were examined for unidimensionality, reliability and validity. Although most of the scales were validated in past studies, principal component factor analysis with varimax rotation was applied to purify the measures and identify their dimensionality. Item-to-total correlation and internal consistency analysis were used to examine the reliability of each factor. Table 3 shows correlation matrix of the constructs. Composite reliability values represent the shared variance among a set of observed variables that measure an underlying construct (Fornell & Larcker, 1981). As shown in Table 4, composite reliability for each of the constructs met the minimum criterion of 0.6 to be considered desirable (Bagozzi & Yi, 1988, p. 82). Apart from the environmental uncertainty construct, all the coefficient alpha values exceeded the threshold value of 0.7 recommended by Nunnally (1978). This suggests that there is a reasonable degree of internal consistency between the corresponding indicators for each of the constructs. Item analysis of the environmental uncertainty identified two items with low item-to-total correlations: “It was hard to know customers’ needs” and “There are many competitors in this industry”. Excluding these two items from the analysis improved coefficient alpha to 0.74. There is also support for convergent validity by all the factor loadings being significant at the 0.001 level

(Bagozzi, Yi, & Phillips, 1991). The final measurement results for the scales together with a correlation matrix are shown in Table 3.

<Take in **Table 4: Results of reliability and factor analysis** >

All the scales were then subjected to confirmatory factor analysis to assess unidimensionality. Measures of overall fit evaluate how well the confirmatory factor analysis model reproduces the observed variables' covariance matrix.  The results of Chi Square fit: $\chi^2 = 249.71$; d.f. = 130; $p = 0.06$; fit indices of the goodness-of-fit index (GFI) 0.95 and adjusted goodness-of-fit index (AGFI) 0.96 are above a minimum value of 0.9 to be considered acceptable (Bagozzi & Yi, 1988). The same threshold value can be applied to the comparative fit index (CFI) 0.98, an incremental fit index suggested by Bentler (1990). The root mean squared error of approximation (RMSEA) value of 0.052 is a fit measure based on the concept of noncentrality (Steiger, 1990). RMSEA values up to 0.08 are usually considered to indicate reasonable model fit (Browne & Cudeck, 1993). These criteria were met in the CFA model, which suggests acceptable levels of fit with items loading significantly onto their designated factors.

Discriminant validity also was supported when significant decreases in $\chi^2$ were observed for the unconstrained model in every case, and none of the value of the confidence intervals had a value of one ($p < .001$). This analysis involved comparing the correlation of a pair of latent variables: one was set at unity and another in which the correlation was free to vary (Fornell & Larcker, 1981). The results suggest that unconstrained models fit the data better than constrained models.

### *3.3. Hypothesis testing*

The procedure for testing the hypotheses involved: (1) multiple regression to examine the influence of situational dimensions on cross-functional integration in NPD stages; and (2) cluster analysis to separate low partner distance from high partner distance groups before performing stepwise regression to examine the influence of situational dimensions on the patterns of cross-functional integration in obtaining a higher NPD performance. This statistical technique produces a parsimonious model as it includes only those variables that significantly contribute to the variance.

In testing hypotheses H1, H2, H3 and H4 the following multiple OLS regression model was applied to the data:

$$Y_1 = \beta_1 + \beta_2\, PNE + \beta_3\, RDE + \beta_4\, DIS + \beta_4\, ENU + \varepsilon$$

Where $Y_1$ is the level of integration in a certain stage,

PNE is the level of product newness,

RDE is the level of R&D experience,

DIS is the distance between partner companies,

ENU is the level of environmental uncertainty.

It was tested four times on the dependent variables of INR (i.e. R&D-R&D' integration in the Initial stage), EVR (i.e. R&D-R&D' integration in the Engineering Validation Test stage), DVR (i.e. R&D-R&D' integration in the Design Validation Test stage), and PVR (i.e. R&D-R&D' integration in the Production Validation Test stage), separately (see Table 5).

<Take in **Table 5: Multiple regression results of situational dimensions and R&D-R&D' integration**>

## 4. Data Analysis and Results

Table 5 shows the four situational dimensions have a jointly significant effect upon the R&D-R&D’ integration in all of the four stages: Model 1 ($R^2$=0.228, F=6.731, P<0.01), Model 2 ($R^2$=0.184, F=5.396, P<0.01), Model 3 ($R^2$=0.180, F=4.709, P<0.01), and Model 4 ($R^2$=0.078, F=2.091, P<0.1). The findings showed that the product newness has positive but insignificant correlation coefficients in all of the four models with an exception of PVR (Production Validation Test) stage in which it has a negative but insignificant effect on R&D-R&D’ integration. These findings indicate that the product newness has no significant effects on the level of R&D-R&D’ integration in any of the NPD stages. Therefore, H1 is not supported. The partner distance has significant positive correlation coefficients in all of the four models: Model 1 (β=0.327, t=3.810, P<0.01), Model 2 (β=0.340, t=3.461, P<0.01), Model 3 (β=0.402, t=3.705, P<0.01), and Model 4 (β=0.376, t=2.821, P<0.01). The results indicate that the partner distance has significant effects on R&D-R&D’ integration in the Initial, EVT, DVT, and PVT stages. Thus, H2 is fully supported. The environmental uncertainty is only significant in Model 1 (β= 0.299, t=3.610, P<0.01), indicating that in the Initial stage, higher environmental uncertainties lead to greater R&D-R&D’ integration. However, in EVT and DVT stages, the effect is not significant, though a negative correlation coefficient is found in the PVT stage. Therefore, H3 is partially supported. The R&D experience has negative correlation coefficients in all of the four models, and it is significant in Model 2 (β= -0.216, t= -2.321, P<0.05) and Model 3 (β= -0.202, t= -2.301, P<0.05), indicating the R&D experience has a significant negative effect on the level of R&D-R&D’ integration in EVT (Engineering Validation Test) and DVT (Design Validation Test) stages. As a result, we reject H4.

<Take in **Table 6: Stepwise regression results of high and low product newness groups**>

To examine the influence of situational dimensions on the hypothesized relationships (H5 to H12) between cross-functional integration and NPD performance, cluster analysis was applied to separate high from low groups of product newness, partner distance, environmental uncertainty and R&D experience. The influence of high product newness (and partner distance, environmental uncertainty, R&D experience) versus low product newness (and partner distance, environmental uncertainty, R&D experience) on NPD performance was analyzed following Song et al. (1998) and Olson et al.'s (2001) analytical procedures of K-means cluster analysis and stepwise regression analysis.

The K-means cluster analysis identified (a) 136 cases as having 'high product newness' and 66 cases as having 'low product newness'; (b) 49 cases as having 'high R&D experience' and 153 cases as having 'low R&D experience'; (c) 58 cases as having 'high partner distance' and 144 cases as having 'low partner distance'; and (d) 96 cases as having 'high environmental uncertainty' and 106 cases as having 'low environmental uncertainty'. These homogeneous groups of high versus low allowed the analysis to compute two models for each situational dimension giving a total of six models (see Table 6).

In the high product newness group (Model 5), the result shows two variables having significant positive effects on NPD performance, they are INC (cross-functional R&D-marketing-production integration within company in the Initial stage) ($\beta=0.328$, $t=2.817$, $P<0.01$) and EVR (R&D-R&D' integration in the Engineering Validation Test stage) ($\beta=0.529$, $t=3.891$, $P<0.01$). In the low product newness group (Model 6), the result also shows two variables have significant positive effects on NPD performance. They are INR (R&D-R&D' integration in the Initial stage) ($\beta=0.395$, $t=4.291$, $P<0.01$) and PVC (cross-functional R&D-marketing-production integration within company in the Production Validation Test stage) ($\beta=0.618$, $t=4.710$, $P<0.01$). These results provide some support H5 while H6 is supported regardless of the low or high product newness.

In the high partner distance group (Model 7), the result shows two variables having a significant positive effect on NPD performance. They are PVR (R&D-R&D' integration in the Production Validation Test stage) (β=0.469, t=4.450, P<0.01) and PVC (cross-functional R&D-marketing-production integration within company in the Production Validation Test stage) (β=0.497, t=5.109, P<0.01). In the low partner distance group (Model 8), the result shows three variables having a significant positive effect on NPD performance. They are INR (R&D-R&D' integration in the Initial stage) (β=0.347, t=2.680, P<0.05), DVP (R&D-production integration in the Design Validation Test stage) (β=0.432, t=2.853, P<0.01), and PVR (R&D-R&D' integration in the Production Validation Test stage) (β=0.389, t=3.582, P<0.01). In the high partner distance group, the result is consistent with the hypothesis that in the PVT (Production Validation Test) stage, R&D-R&D' integration has significant effects on NPD performance (β=0.469, t=4.450, P<0.05). However, there is no empirical evidence on the positive effect of R&D-R&D' integration in the Initial, EVT and DVT stages on NPD performance in high partner distance situations. Therefore, H7 is partially supported. Similarly, since R&D-marketing-production integration within company has significant effect on NPD only in the PVT stage, (β=0.497, t=5.109, P<0.05) but not in the Initial stage, H8 is partially supported.

In the high environmental uncertainty group (Model 9), the result shows two variables having a significant positive effect on NPD performance, they are INC (cross-functional R&D-marketing-production integration within company in the Initial stage) (β=0.418, t=3.471, P<0.05) and PVR (R&D-R&D' integration in the Production Validation Test stage) (β=0.412, t=4.918, P<0.05). In the low environmental uncertainty (Model 10), the result shows also two variables having a significant positive effects on NPD performance, they are INC (cross-functional R&D-marketing-production integration within company in the Initial stage) (β=0.418, t=3.482, P<0.05) and EVR (R&D-R&D' integration in the Engineering

Validation Test stage) (β=0.726, t=5.387, P<0.05). These results partially support H9 and H10.

Finally, in the high R&D experience group (Model 11), the result shows only one variable, INC (cross-functional R&D-marketing-production integration within company in the Initial stage) (β=0.663, t=3.579, P<0.05), has significant positive effects on NPD performance. In the low R&D experience group (Model 12), the results show three variables having significant positive effects on NPD performance. They are INR (i.e., R&D-R&D' integration in the Initial stage) (β=0.248, t=2.271, P<0.05), EVR (R&D-R&D' integration in the Engineering Validation Test stage) (β=0.358, t=3.591, P<0.05), and PVC (cross-functional R&D-marketing-production integration within company in the Production Validation Test stage) (β=0.435, t=5.290, P<0.05). Thus, with low R&D experience, the integration between host R&D-partner R&D' has significant effects on NPD performance in all NPD stages except Production Validation Test (PVT) stage. However, since we could not observe any significant effect of high R&D experience situations on NPD success of interfirm R&D integration, we rejected H11. As we only observed NPD success of R&D-marketing-production integration in the Initial stage, we could partially support H12.

## 5. Discussion

### *5.1. Implications for theory and research*

The role of situational dimensions in R&D-R&D' integration needs to be examined against relevant NPD stages. The partner distance has the most salient effect on NPD performance between host R&D-partner R&D' integration. The level of R&D experience has a significant negative effect on R&D-R&D' integration except in the Initial stage and Production Validation stage. Indeed, R&D-R&D' integration is not related to NPD success when firms have high R&D experience. This is because alliance success may rely on previous alliance experience (e.g., Simonin, 1997; Barkema, Sheker, Vermeulen, & Bell 1997; Anand & Khanna, 2000). Furthermore, by focusing on generative learning of new knowledge rather than routine-based learning (experience), R&D-R&D' integration may increase NPD success (Eisenhardt and Martin, 2000).

It is important to consider intrafirm integration across multiple functions namely R&D-marketing-production in the context of R&D partnerships. For instance, the effect of environmental uncertainty on NPD performance may vary at different NPD stages depending on types of cross-functional integration. In this study, environmental uncertainty is significant in the Initial stage of cross functional integration within the firm but it is insignificant in the other stages.

In a high product newness group, R&D-marketing-production integration in the Initial Stage is crucial to NPD performance, but for R&D-R&D' integration only the Engineering Validation Test Stage is significant. In a low product newness group, NPD performance is positively influenced by the integration between R&D partners in the Initial stage, and between functions within the company in the Product Validation Test stage. However, product newness does not have any significant influences on host and partner R&D integration. This is because Chinese manufacturing firms may rely on a low cost strategy rather than on invention of new products compared to well-established industrialized nations such as the US and the UK. Future research could examine the nature of R&D partnerships of Chinese manufacturing firms with international partners to determine types of product differentiation and differences between partners.

When the distance between two R&D partners is large, greater integration in the Product Validation Test stage within the company and R&D-R&D' is the key to higher NPD performance. In contrast, when the distance between two R&D partners is not large, the integration between R&D partners in the Initial stage, Product Validation Test stage, and between R&D-production functions in the Design Validation Test stage is crucial for NPD performance. This provides support for the importance of cooperation between distant partnering firms in NPD alliances for high-tech and complex products (Miotti & Sachwald, 2003), though the relationship between marketing-production would need to be examined in further research. In a high environmental uncertainty, a greater integration between functions within the company in the Initial stage and between R&D partners in the Product Validation Test stage are most crucial to the NPD performance. Compared to a low environmental uncertainty, the integration between functions within a company in the Initial stage, and between R&D partners in the Engineering Validation Test stage is most significant for NPD performance. As such, it is important to distinguish the levels between intrafirm from interfirm integration in R&D partnerships for NPD. However, further research might identify more specific situational dimensions, e.g., ‘business culture’, ‘risk behavior’. The overall result is consistent with Cooper’s (1983) classification that new product success is largely determined by the way a firm conceives, develops and commercializes the new product, and the level of cross-functional integration should correspond to different situations (Yap & Souder, 1994; Song et al., 1998; Sherman et al., 2005).  Thus, this study has extended the influence of situational dimensions on cross-functional integration in achieving a higher NPD performance into the context of emerging economies such as China.

### *5.2. Implications for managers*

In high product newness, a high degree of integration between host R&D and partner-R&D is most crucial for NPD performance in the Engineering Validation Test stage. Within the firm, managers should also forge a high degree of integration of R&D-marketing-production in the Initial stage of NPD process when the product newness is high. Cross-functional integration is important for NPD performance in the Initial stage of R&D-R&D’ particularly when the level of R&D experience is low, though R&D experience is crucial for R&D-marketing-production integration particularly when R&D experience is high. Firms that create a dedicated function of alliance management in NPD collaboration can enhance alliance success (Kale & Singh, 2007), and hence a high degree of integration across initial and engineering validation stages of NPD process is important for NPD success when R&D experience is low.

Although R&D teams tend to develop a high level of integration with geographically distance partners, the types of cross-functional integration that should be emphasized to enhance NPD performance vary at different NPD stages. In the context of this study, when the distance between two R&D partners is large, firms should focus on greater integration in the Product Validation Test stage to improve NPD success. However, when the distance between two R&D partners is not large, firms should pay more attention to the integration between R&D partners in the Initial stage, Product Validation Test stage, and between R&D-production in the Design Validation Test stage. The results imply that a higher degree of differences between two R&D partners can have a more positive impact on new product success particularly in production validation stage. Thus, managers should focus on collaboration with distant R&D partners with a greater opportunity to find complementary resources than similar partners such as firms operating in the same industry during the production process.

With regard to the influence of environmental uncertainty on the degree of cross-functional integration, it is far from the simple generalization of a direct relationship between environmental uncertainty and levels of cross-functional integration (e.g., Koufteros et al., 2002). In highly uncertain environments, firms should focus on integration of R&D-marketing-production in the Initial stage while R&D-R&D’ integration in the Product Validation Test stage to improve new product performance. Although the results show that firms should also focus on integration of R&D-marketing-production in the Initial stage in a low environmental uncertainty, it is important for R&D partners to integrate their effort in the Product Validation Test stage. The overall result suggests that managers not only face with changes of situational (environmental) dimensions but they also need to recognize the levels of integration practices in NPD process to enhance new product success.

The study also has useful implications for government policy makers. The Chinese government emphasized the importance of R&D to sustain the country's economic growth and to raise manufacturing outputs of Chinese brands in international markets. This study shows that high distance R&D partners (e.g., cultural and capability differences) have more potential to improve NPD performance as well as integration in different NPD stages than low distance R&D partners. The Chinese government can help the manufacturing industry to increase international R&D partnerships and collaboration by providing incentives and reducing bureaucracy for local and foreign firms such as tax relief and reliable information technology, and better enforcement of intellectual property rights and transparent business regulations. As greater resources need to be channelled into integration of intrafirm activities (such as R&D-marketing-production) in highly uncertain environments, policy makers play an important role in reducing legal and political uncertainties, which would encourage foreign firms to partner with Chinese manufacturing firms. On a general level, the economic performance of manufacturing industries in emerging economies relies on NPD success in a global market that requires knowledge about international R&D partnerships and intrafirm cross-functional integration to support the government policy on transforming imitative to innovative capabilities.

**Figure 1: The Conceptual Framework**

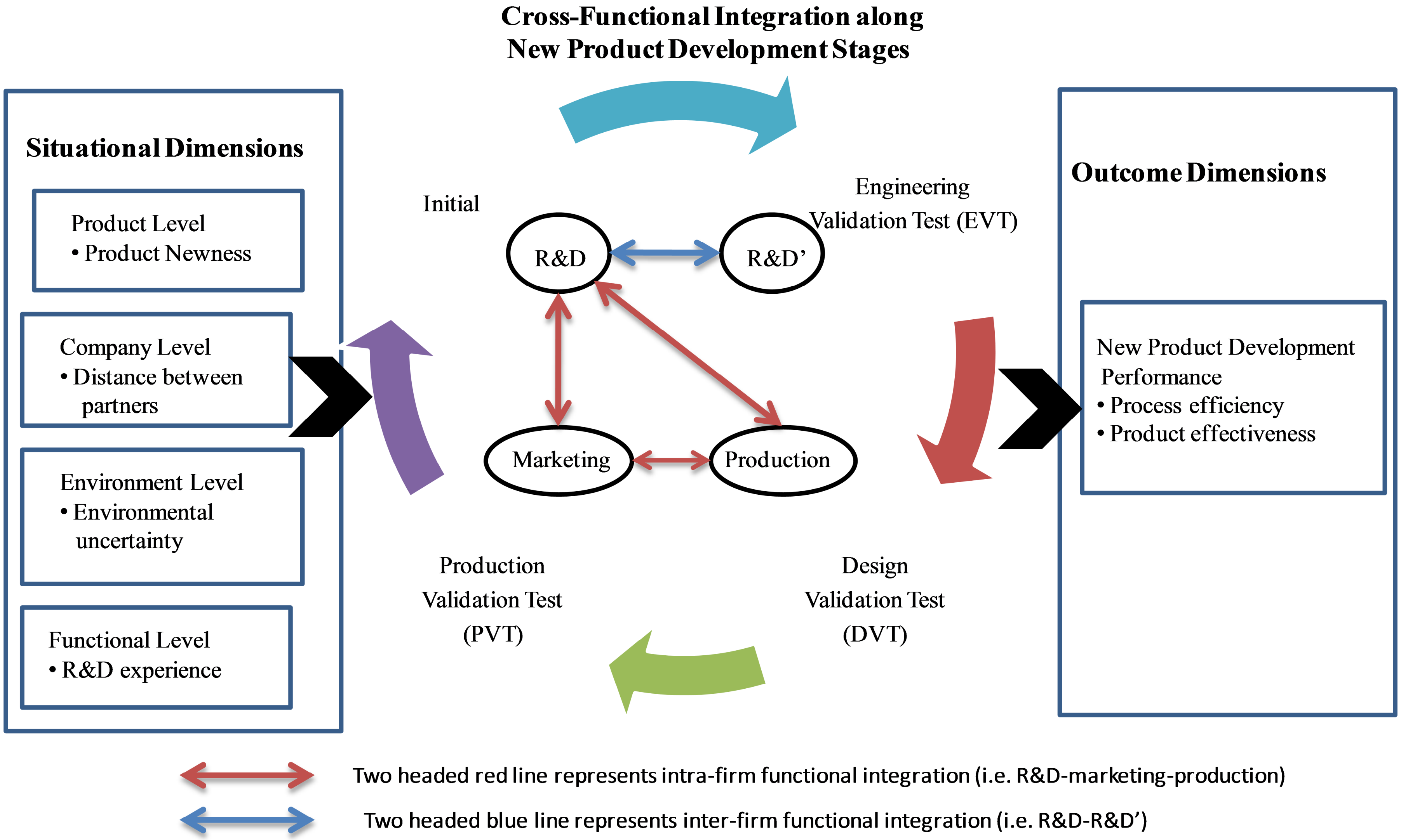

**Table 1: Common NPD Process in China's electronics and/or high-technology manufacturing industry**

| | Initial stage | EVT stage | DVT stage | PVT stage |
|---|---|---|---|---|
| Host division | Marketing and R&D | R&D | R&D | R&D and Production |
| Objectives | Features and sales point<br>New technology and key devices<br>Environment concept<br>Quality plan<br>Design target list | Prototype developed<br>Use mock-up or eve T1 housing for pilot run<br>Key component functions workable | Use MP housing for pilot run<br>H/W fix<br>Reliability test | Product should be very mature, similar to MP Product<br>Factory tune production process for the preparation of MP |
| Output / Requirement | Product spec 1.0<br>Project team member<br>Project schedule | EVT test report<br>EMC/Safety submission<br>Black diagram/Circuit explanation<br>Testing<br>Pg free parts check<br>Corrosion test | DVT test report<br>Yield rate report<br>Component verification<br>Customer verification<br>Dust test | PVT test report<br>Yield rate report<br>Failure analysis report<br>Golden sample<br>Online preparation list<br>Product spec |

Note:

EVT= Engineering validation test stage, DVT= Design validation test stage, PVT= Production validation test stage stage.

**Table 2: A Review of Prior Research Cross-Functional Integration**

| | Type of integration | | |
|---|---|---|---|
| **Decision areas** | **Inter-firm integration** | **Intra-firm integration** | **Functions Analysed** |
| New product development | | Calantone and Rubera (2012) | R&D-engineering-marketing |
| | | Brettel et al. (2011) | R&D-marketing-manufacturing |
| | | Zhang et al. (2011) | Marketing-industrial design |
| | | Perks et al. (2009) | R&D-marketing |
| | | Troy et al. (2008) | R&D-marketing |
| | | Swink and Song (2007) | Marketing-manufacturing |
| | | Garrett et al. (2006) | R&D-marketing |
| | | Song and Thieme (2006) | R&D-marketing |
| | | Beverland (2005) | Marketing-design |
| | | Veryzer (2005) | Marketing-industrial design |
| | | Gomes et al. (2003) | R&D-marketing |
| | | Calantone et al. (2003) | Marketing-manufacturing |
| | | Song and Swink (2002) | Marketing-manufacturing |
| | | Kahn (2001) | R&D-marketing-manufacturing |

|  |  |  |  |
|---|---|---|---|
|  |  | Olson et al. (2001) | Marketng-operations-R&D |
|  |  | Song and Montoya-Weiss (2001) | R&D-marketing-manufacturing |
|  |  | Athuahene-Gima and Evangelista (2000) | R&D-marketing |
|  |  | Sherman et al. (2000) | R&D-customer-supplier-manufacturer |
|  |  | Song and Xie (2000) | R&D-manufacturing-marketing |
|  |  | Song et al. (2008) | R&D-marketing-manufacturing |
|  |  | Souder et al. (1998) | R&D-marketing-customer |
|  |  | Kahn and McDonough (1997) | Marketing-manufacturing-R&D |
|  |  | Kahn (1996) | Marketing (sales)-manufacturing (operations)- R&D (engineering) |
|  |  | Parry and Song (1993) | R&D-marketing |
|  |  | Griffin and Hauser (1992) | Marketing-manufacturing-engineering |
|  |  | Song and Parry (1992) | R&D-marketing |
|  |  | Hise (1990) | R&D-marketing |
| R&D | Miotti and Sachwald (2003) |  | Inter-firm R&D cooperation |
| Product design |  | Michalek et al. (2005) | Marketing-engineering-product design |
|  |  | Ettlie (1997) | Marketing-R&D-production |

| | | | |
|---|---|---|---|
| Operations | | Pagell (2004) | Operations-purchasing-logistics |
| | | Hausman et al. (2002) | Marketing-manufacturing |
| | | Tatikonda and Montoya-Weiss (2001) | Marketing-operations |
| | | Malz and Kahli (2000) | Marketing-finance-manufacturing-R&D |
| | | Ettlie (1995) | Design engineering-manufacturing engineering |
| Marketing/sales | | O’Leary-Kelly and Flores (2002) | Manufacturing-marketing/sales |
| New product manufacturability | Swink (1999) | Swink (1999) | Manufacturing involvement, supplier influence |

**Table 3: Correlation matrix**

| **Variable** | **Mean**$^a$ | **S.D.** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|---|---|---|
| **1. Product newness** | 3.41 | 0.85 | - | | | | | | |
| **2. Distance (R&D)** | 3.26 | 1.04 | 0.268* | - | | | | | |
| **3. Environmental uncertainty** | 2.17 | 1.08 | 0.143 | 0.237 | - | | | | |
| **4. Integration (R&D-R&D')** | 3.57 | 0.72 | 0.081** | 0.263 | 0.291 | - | | | |
| **5. Integration (R&D-Mktg)** | 3.45 | 0.81 | 0.147 | 0.162 | 0.295* | 0.283 | - | | |
| **6. Integration (R&D-Prod)** | 3.38 | 1.24 | 0.173** | 0.248** | 0.051 | 0.306 | 0.109 | - | |
| **7. NPD performance** | 3.28 | 0.83 | 0.226 | 0.195 | 0.410 | 0.159 | 0.495* | 0.308 | - |

Pearson correlation coefficient; two-tailed test of significance is used. Significant at **$p < 0.01$, * $p < 0.05$

S.D. = Standard deviation; $^a$ = Average score across the items (on a 5-point scale: '1=strongly disagree' and '5=strongly agree')

**Table 4: Results of reliability and factor analysis**

| Construct | Cronbach's alpha | Average Variance Extracted | Composite reliability | Items | Factor loadings* | Item-to-total correlation |
|---|---|---|---|---|---|---|
| Product Newness (Jin, 2001; Tatikond and Montoya-Weiss, 2001) | 0.742 | 0.54 | 0.79 | -How new, on average, were the product configurations? | 0.702 | 0.588 |
| | | | | -How new were the key technologies being implemented in this project? | 0.671 | 0.793 |
| | | | | -How familiar were your team with the technologies? | 0.801 | 0.682 |
| Distance (R&D) | 0.826 | 0.58 | 0.78 | -What is the approximate working hour overlap between your company and the foreign company? | 0.682 | 0.530 |
| | | | | -How big id you feel the cultural differences between your company and the foreign company? | 0.691 | 0.705 |
| | | | | -How big did you feel the technology capability difference between your company and the foreign company? | 0.720 | 0.682 |
| Environmental uncertainty (Griffin and Hauser, 1996; Lu and Yang, 2004) | 0.742 | 0.70 | 0.68 | -It was hard to know customers' needs. | 0.810 | 0.582 |
| | | | | -It was hard to understand competitor's strategies. | 0.795 | 0.640 |
| | | | | -It was difficult to acquire technology. | 0.801 | 0.739 |
| | | | | -Technology changes rapidly in this industry. | 0.797 | 0.846 |
| | | | | -There are many competitors in this industry. | 0.702 | 0.741 |

| | | | | | |
|---|---|---|---|---|---|
| Integration (R&D-R&D’)<br>(Adapted from Lu and Yang, 2004; Song et al., 1998) | 0.721 | 0.54 | 0.75 | -Jointly discuss customer’s requirements at the beginning of the project. | 0.736 | 0.593 |
| | | | | -Jointly establish the project schedule (timetable). | 0.620 | 0.782 |
| | | | | -Share the information about environment (customer country’s regulations, competitors...). | 0.818 | 0.846 |
| | | | | -There were frequent face-to-face meetings during the initial stage. | 0.702 | 0.792 |
| | | | | -Share and analyze the result of engineering validation test stage test report. | 0.808 | 0.803 |
| | | | | -There were frequent e-mail contacts and conference calls during the engineering validation test stage. | 0.755 | 0.760 |
| | | | | -There were frequent face-to-face meetings during the engineering validation test stage. | 0.755 | 0.692 |
| | | | | -Share and analyze the result of design validation test stage test report. | 0.814 | 0.795 |
| | | | | -There were frequent email contacts and conference calls during the design validation test stage. | 0.759 | 0.683 |
| | | | | -There were frequent face-to-face meetings during the design validation test stage. | 0.681 | 0.582 |
| | | | | -Jointly determine the desired product features and their feasibility. | 0.836 | 0.749 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | -Share and analyze the result of production validation test stage test report. | 0.711 | 0.637 |
| | | | | -There were frequent e-mail contacts and conference calls during the production validation test stage. | 0.849 | 0.743 |
| | | | | -There were frequent face-to-face meetings during the production validation test stage. | 0.748 | 0.671 |
| | | | | -There were frequent e-mail contacts and conference calls during the mass production stage. | 0.830 | 0.795 |
| | | | | -There were frequent face-to-face meetings during the mass production stage. | 0.791 | 0.690 |
| | | | | -Jointly work continuously for cost reduction and quality improvement. | 0.757 | 0.649 |
| Integration (R&D-Mktg)<br>(Adapted from Lu and Yang, 2004; Song et al., 1998) | 0.708 | 0.62 | 0.71 | -Jointly discuss customer's requirements at the beginning of the project. | 0.748 | 0.793 |
| | | | | -Jointly establish the project schedule (timetable). | 0.787 | 0.846 |
| | | | | -Share the information about environment (customer country's regulations, competitors...). | 0.852 | 0.720 |
| | | | | -There were frequent face-to-face meetings during the initial stage. | 0.741 | 0.682 |
| | | | | -Share and analyze the result of engineering validation test stage test report. | 0.639 | 0.602 |

| | | | |
|---|---|---|---|
| | -There were frequent e-mail contacts and conference calls during the engineering validation test stage. | 0.729 | 0.686 |
| | -There were frequent face-to-face meetings during the engineering validation test stage. | 0.847 | 0.793 |
| | -Share and analyze the result of design validation test stage test report. | 0.904 | 0.836 |
| | -There were frequent email contacts and conference calls during the design validation test stage. | 0.862 | 0.753 |
| | -There were frequent face-to-face meetings during the design validation test stage. | 0.913 | 0.848 |
| | -Jointly determine the desired product features and their feasibility. | 0.741 | 0.693 |
| | -Share and analyze the result of production validation test stage test report. | 0.749 | 0.703 |
| | -There were frequent e-mail contacts and conference calls during the production validation test stage. | 0.860 | 0.750 |
| | -There were frequent face-to-face meetings during the production validation test stage. | 0.905 | 0.862 |
| | -There were frequent e-mail contacts and conference calls during the mass production stage. | 0.674 | 0.582 |
| | -There were frequent face-to-face meetings during the mass production | 0.704 | 0.693 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | stage. | | |
| | | | | -Jointly work continuously for cost reduction and quality improvement. | 0.809 | 0.759 |
| Integration (R&D-Prod)<br>(Adapted from Lu and Yang, 2004; Song et al., 1998) | 0.951 | 0.58 | 0.720 | -Jointly discuss customer's requirements at the beginning of the project. | 0.781 | 0.741 |
| | | | | -Jointly establish the project schedule (timetable). | 0.683 | 0.729 |
| | | | | -Share the information about environment (customer country's regulations, competitors...). | 0.949 | 0.873 |
| | | | | -There were frequent face-to-face meetings during the initial stage. | 0.810 | 0.794 |
| | | | | -Share and analyze the result of engineering validation test stage test report. | 0.929 | 0.805 |
| | | | | -There were frequent e-mail contacts and conference calls during the engineering validation test stage. | 0.787 | 0.865 |
| | | | | -There were frequent face-to-face meetings during the engineering validation test stage. | 0.806 | 0.750 |
| | | | | -Share and analyze the result of design validation test stage test report. | 0.751 | 0.728 |
| | | | | -There were frequent email contacts and conference calls during the design validation test stage. | 0.840 | 0.765 |
| | | | | -There were frequent face-to-face meetings during the design validation test stage. | 0.793 | 0.733 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | -Jointly determine the desired product features and their feasibility. | 0.924 | 0.853 |
| | | | | -Share and analyze the result of production validation test stage test report. | 0.783 | 0.698 |
| | | | | -There were frequent e-mail contacts and conference calls during the production validation test stage. | 0.691 | 0.688 |
| | | | | -There were frequent face-to-face meetings during the production validation test stage. | 0.748 | 0.734 |
| | | | | -There were frequent e-mail contacts and conference calls during the mass production stage. | 0.815 | 0.717 |
| | | | | -There were frequent face-to-face meetings during the mass production stage. | 0.756 | 0.753 |
| | | | | -Jointly work continuously for cost reduction and quality improvement. | 0.831 | 0.536 |
| NPD performance (Verona, 1999; Lu and Yang, 2004) | 0.863 | 0.60 | 0.847 | -The cost was within the budget. | 0.684 | 0.582 |
| | | | | -The project could meet the schedule. | 0.749 | 0.793 |
| | | | | -We are satisfied with the first mass production yield rate. | 0.802 | 0.788 |
| | | | | -We are satisfied with the product quality. | 0.729 | 0.682 |
| | | | | -Overall, we feel satisfied with the product. | 0.848 | 0.756 |

Fit indices: $\chi^2$ = 249.71; d.f. = 130; $p$ = 0.06; non-normed fit index (NNFI) = 0.97; comparative fit index (CFI) = 0.98; goodness of fit index (GFI) = 0.95; adjusted goodness of fit index (AGFI) = 0.96; root mean square residual (RMSR) = 0.031; root mean squared error of approximation (RMSEA) = 0.052. $^*p \leq 0.01$

**Table 5: Multiple regression results of situational dimensions and R&D-R&D’ integration**

| | **Model 1** | | | **Model 2** | | | **Model 3** | | | **Model 4** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INR (Initial stage R&D-R&D’) | | | EVR (Engineering validation stage R&D-R&D’) | | | DVR (Design validation stage R&D-R&D’) | | | PVR (Production validation stage R&D-R&D’) | | |
| | $\beta$ | *t* | *P* | B | *T* | *P* | $\beta$ | *t* | *p* | $\beta$ | *t* | *p* |
| **(Constant)** | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 |
| **PNE** | 0.050 | 0.602 | 0.588 | 0.217 | 1.395 | 0.138 | 0.087 | 1.003 | 0.317 | -0.038 | -0.271 | 0.812 |
| **DIS** | 0.327*** | 3.810 | 0.000 | 0.340*** | 3.461 | 0.001 | 0.402*** | 3.705 | 0.000 | 0.376*** | 2.821 | 0.004 |
| **ENU** | 0.299*** | 3.610 | 0.001 | 0.138 | 1.482 | 0.181 | 0.086 | 0.846 | 0.391 | -0.028 | -0.205 | 0.793 |
| **RDE** | -0.105 | -1.146 | 0.248 | -0.216** | -2.321 | 0.028 | -0.202** | -2.301 | 0.032 | -0.076 | -0.758 | 0.477 |
| **F-value** | | 6.731 | | | 5.396 | | | 4.709 | | | 2.091 | |
| **P-value** | | 0.000*** | | | 0.001*** | | | 0.001*** | | | 0.087* | |
| **R$^2$** | | 0.228 | | | 0.184 | | | 0.180 | | | 0.078 | |
| **Adjusted R$^2$** | | 0.189 | | | 0.148 | | | 0.137 | | | 0.036 | |

Note: *$P$ <0.1; **$P$<0.05; *** $P$<0.01

Note: PNE=Product Newness, RDE=R&D Experience, DIS=Distance, ENU=Environmental Uncertainty

**Table 6: Stepwise regression results of high and low product newness groups**

| | Model 5 | | Model 6 | | Model 7 | | Model 8 | | Model 9 | | Model 10 | | Model 11 | | Model 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *High Product Newness Group NPP* | | *Low Product Newness Group NPP* | | *High Partner Distance Group NPP* | | *Low Partner Distance Group NPP* | | *High Env. Uncertainty Group NPP* | | *Low Env. Uncertainty Group NPP* | | *High R&D Experience Group NPP* | | *Low R&D Experience Group NPP* | |
| | B | *t* | B | *t* | B | *t* | B | *t* | B | *t* | B | *t* | B | *t* | B | *t* |
| Constant | 0.038 | 0.317<br>(0.752) | -0.065 | -0.814<br>(0.518) | 0.019 | 0.218<br>(0.823) | 0.073 | 0.628<br>(0.520) | 0.197 | 2.389<br>(0.027) | -0.174 | -1.376<br>(0.141) | -0.221 | -1.486<br>(0.120) | -0.013 | -0.215<br>(0.852) |
| INR | | | 0.395 | 4.291<br>(0.000) | | | 0.347 | 2.680<br>(0.013) | | | | | | | 0.248 | 2.271<br>(0.015) |
| INC | 0.328 | 2.817<br>(0.009) | | | | | | | 0.418 | 3.471<br>(0.000) | 0.418 | 3.482<br>(0.002) | 0.663 | 3.579<br>(0.001) | | |
| EVR | 0.529 | 3.891<br>(0.002) | | | | | | | | | 0.726 | 5.387<br>(0.000) | | | 0.358 | 3.591<br>(0.001) |
| EVC | | | | | | | | | | | | | | | | |
| DVR | | | | | | | | | | | | | | | | |
| DVM | | | | | | | | | | | | | | | | |
| DVP | | | | | | | 0.432 | 2.853<br>(0.005) | | | | | | | | |
| PVR | | | | | 0.469 | 4.450<br>(0.000) | 0.389 | 3.582<br>(0.002) | 0.412 | 4.918<br>(0.000) | | | | | | |
| PVC | | | 0.618 | 4.710<br>(0.000) | 0.497 | 5.109<br>(0.000) | | | | | | | | | 0.435 | 5.290<br>(0.000) |
| F - value | 8.791 | | 31.728 | | 19.291 | | 20.917 | | 21.651 | | 21.652 | | 12.978 | | 21.000 | |
| P - value | 0.001 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.001 | | 0.000 | |
| $R^2$ | 0.284 | | 0.547 | | 0.562 | | 0.629 | | 0.523 | | 0.511 | | 0.265 | | 0.528 | |
| Adjusted $R^2$ | 0.274 | | 0.528 | | 0.619 | | 0.568 | | 0.511 | | 0.472 | | 0.249 | | 0.501 | |

Note: Stepwise criteria: Probability-of-F-to-enter ≤ 0.05; Probability-of-F-to-remove ≥ 0.1; Value of *p* in parentheses.

Note: INR=R&D-R&D’ integration in the Initial stage, INC=Cross functional R&D-Marketing-Production integration within company in the Initial stage, EVR=R&D-R&D’ integration in the Engineering Validation Test stage, EVC= Cross functional R&D-Marketing-Production

integration within company in the Engineering Validation Test stage, DVR= R&D-R&D’ integration in the Design Validation Test stage, DVM=R&D-Marketing integration in the Design Validation Test stage, DVP=R&D-Production integration in the Design Validation Test stage, PVR= R&D-R&D’ integration in the Production Validation Test stage, PVC= Cross functional R&D-Marketing-Production integration within company in the Production Validation Test stage

## 6. References

Adler, J. (1995). *Environmentalism at Crossroads.* Washington,Capital Research Center.

Anand, B., & Khanna, T. (2000). Do firms learn to create value? The case of alliances. *Strategic Management Journal*, 21(3), 295-316.

Auh, S., & Menguc, B. (2005). The influence of top management team functional diversity on strategic orientations: The moderating role of environmental turbulence and inter-functional coordination. *International Journal of Research in Marketing*, 22, 333-350.

Bagozzi, R.P., & Yi, Y. (1988). On the Evaluation of Structural Equation Models. *Journal of the Academy of Marketing Science*, 16(1), 74-94.

Bagozzi, R.P., Yi, Y., & Phillips, L.W. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly*, 36, 421–458.

Barkema, H.G., Sheker, O., Vermeulen, F., & Bell, J.H. (1997). Working abroad, working with others: how firms learn to operate international joint ventures. *Academy of Management Journal*, 40(2), 426-442.

Bentler, P.M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin*. 107(2), 238–246.

Bidault, F., & Cummings, T. (1994). Innovating through alliances: expectations and limitations. *R&D Management*, 21(1), 33-45.

Brettel, M., Heinemann, F., Engelen, A., & Neubauer, S. (2011). Cross-functional integration of R&D, marketing and manufacturing in radical and incremental product innovations and its effects on project innovativeness and efficiency. *Journal of Product Innovation Management*, 28, 251-269.

Boyd, K.B., Dess, G.G., & Rasheed, A.M.A. (1993). Divergence between perceptual and archival measures of the environment: causes and consequences. *Academy of Management Review*, 18, 204-226.

Brislin, R. W. (1970). Back-translation for cross-cultural research. *Journal of Cross-Cultural Psychology*, 1(3), 185-216.

Bucklin, L.P., & Sengupta, S. (1993). Organizing successful co-marketing alliances. *Journal of Marketing*, 57(2), 32-46.

Calantone, R., & Rubera, G. (2012). When should RD&E and Marketing collaborate? The moderating role of exploration-exploitation and environmental uncertainty. *Journal of Product Innovation Management*, 29(1), 144-157.

Calantone, R., Droge, C., Vickery, S. (2002). Investigating the manufacturing-marketing interface in new product development: does context affect the strength of relationships?. *Journal of Operations Management*, 20, 273-287.

Cooper, R.G. (1994). Perspective: Third-Generation New Product Process. *Journal of Product Innovation Management*. 11, 3-14.

Dougherty, D. (1996). Organizing for innovation. In S.R. Clegg, C. Hardy, & W. R. Nord (Eds.), *Handbook of Organization Study* (pp. 424-439). Thousand Oaks, CA: Sage Publications.

Eisenhardt, K.M., & Martin, J. (2000). Dynamic capabilities: What are they?. *Strategic Management Journal*, 21, 1105-1121.

Eng, T.Y, & Spickett-Jones, J.G. (2009). An investigation of marketing capabilities and upgrading performance of manufacturers in mainland China and Hong Kong. *Journal of World Business*, 44(4), 463-475.

Ettlie, J. E. (1997). Integrated design and new product success. *Journal of Operations Management*, 15, 33-55.

Eppinger, S.D., & Chitkara, A.R. (2006). The new practice of global product development. *MIT Sloan Management Review*, 47(4), 22-30.

Ernst, H., Hoyer, W.D., & Rübsaamen, C. (2010). Sales, marketing, and research-and-development cooperation across NPD stages: Implications for success. *Journal of Marketing,* 74, 80-92.

Ettlie, J.E. (1995). Product-Process Development Integration in Manufacturing. *Management Science*, 41(7), 1224-1237.

Ettlie, J.E., & Pavlou, P.A. (2006). Technology-based new product development partnerships. *Decision Sciences*, 37(2), 117-147.

Fernandez, P., Del Rio, M.L., Varela, J., & Bande, B. (2010). Relationships among functional units and new product performance: The moderating effect of technological turbulence. *Technovation*, 30, 310-321.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* 48, 39–50.

Galbraith, J. (1973). *Designing Complex Organizations.* Reading: Addison-Wesley Publishing Co.

Ganesan, S., Malter, A.J., & Rindfleisch, A. (2005). Does distance still matter? Geographic proximity and new product development. *Journal of Marketing,* 69(4), 44-60.

Garrett, T.C., Buisson, D.H., & Yap, C.M. (2006). National culture and R&D and marketing integration mechanisms in new product development: A cross-cultural study between Singapore and New Zealand. *Industrial Marketing Management*, 35, 293-307.

Ghemawat, P. (2001). Distance still matters. *Harvard Business Review,* 79(8), 137-145.

Gomes, J.F.S., de Weerd-Nederhof, P.C., Pearson, A.W., & Cunha, M.P. (2003). Is more always better? An exploration of the differential effects of functional integration on performance in new product development. *Technovation*, 23, 185-191.

Griffin, A., & Hauser, J. (1996). Integrating R&D and Marketing: A Review and Analysis of the Literature. *Journal of Product Innovation Management*, 13, 191-215.

Gupta, A.K., Raj, S.P., & Wilemon, D. (1986). A model for studying R&D marketing interface in the product innovation process. *Journal of Marketing*, 50(2), 7-17.

Harryson, S.J. (1997). How Canon and Sony drive product innovation through networking and application-focused R&D. *R&D Management*, 14, 288-295.

Hausman, W.H., Montgomery, D.B., & Roth, A.V. (2002). Why should marketing and manufacturing work together? Some exploratory empirical results. *Journal of Operations Management*, 20, 241-257.

Holland, S., Gaston, K., & Gomes, J. (2000). Critical success factors for cross-functional teamwork in new product development. *International Journal of Management Reviews*, 2(3), 231-259.

Huber, G., O’Connell, M., & Cummings, L. (1975). Perceived environmental uncertainty: Effects of information and structure. *Academy of Management Journal*, 18, 725-740.

Industry and Technology Intelligence Services (IT IS), 2007. Taiwan Industrial Outlook, 03 July, 2008. Access date: November 2011 <http://www.itis.org.tw/web/Reports.jsp>

Jin, Z. (2001). The nature of NPD and role flexibility of R&D/ marketing in a fast growing high-tech setting. *R&D Management*, 31(3), 275-285.

Kahn, K.B., & McDonough, E.F. (1997). An empirical study of relationships among co-location, integration, performance, and satisfaction. *Journal of Product Innovation Management*, 14(3), 161-178.

Kale, P., & Singh, H. (2007). Building firm capabilities through learning: The role of the alliance learning process in alliance capability and firm-level alliance success. *Strategic Management Journal*, 28, 981-1000.

Katila, R. (2002). New product search over time: Past ideas in their prime?. *Academy of Management Journal*, 45(5), 995-1010.

Khandwalla, P.N. (1973). Viable and effective organizational designs of firms. *Academy of Management Journal*, 16, 481–495.

Khanna, T., Gulati, R., Nohria, N. (1998). The dynamics of learning alliances, competition, cooperation and relative scope. *Strategic Management Journal,* 19 (3), 193-210.

Kotabe, M., & Swan, K.S. (1995). The role of strategic alliances in high-technology new product development. *Strategic Management Journal*, 16(8), 621-636.

Koufteros, X., Vonderembse, M.A., & Doll, W.J. (2002). Integrated product development practices and competitive capabilities: the effects of uncertainty, equivocality, and platform strategy. *Journal of Operations Management*, 20, 331-355.

Lawrence, P., & Lorsch, J. (1967). Differentiation and Integration in Complex Organizations. *Administrative Science Quarterly*, 12(1), 1-47.

Lee, C., & Chen, W-J. (2007). Cross-functionality and charged behavior of the new product development teams in Taiwan’s information technology industries. *Technovation*, 27, 605-615.

Lenz, R.T. (1980). Environment, strategy, organization structure & performance: Patterns in one industry. *Strategic Management Journal*, 1, 209-226.

Lenz, R.T. (1981). Determinants of organizational performance: an interdisciplinary view. *Strategic Management Journal*, 2(2), 131-54.

Lichtenthaler, U., & Lichtenthaler, E. (2004). Alliance functions: implications of the international multi-R&D-alliance perspective. *Technovation*. 24, 541-552.

Link, A.N., & Bauer, L.L. (1989). *Cooperative research in U.S. manufacturing: Assessing policy initiatives and corporate strategies.* Lexington, MA: Lexington Books.

Lu, L.Y.Y. (2003). *New Product Development in Taiwan’s IT Industry: The Cooperation between R&D and Marketing*, PhD dissertation, Institution of Business and Management, National Chiao Tung University, Taiwan.

Lu, L.Y.Y., & Yang, C. (2004). The R&D and marketing cooperation across new product development stages: An empirical study of Taiwan’s IT industry. *Industrial Marketing Management*, 33: 593-605.

Lyles, M. A. (1988). Learning among joint venture sophisticated firms. *Management International Review,* Special Issue 28, 85-98.

Martin, J.A. (1987). Structural equation modelling: A guide for the perplexed. *Child Development*, 58, 33-37.

McGrath, M.E. (1996). *Setting the PACE in product development*, revised edition. MA: Butterworth-Heinemann.

Miller, D. (1988). Relating Porter's business strategies to environment and structure: Analysis and performance implications. *Academy of Management Journal*, 31, 280-308.

Miotti, L., Sachwald, F. (2003). Co-operative R&D: why and with whom? An integrated framework of analysis. *Research Policy*. 32, 1481-1499.

Nakata, C., & Subin, I. (2010). Spurring Cross-Functional Integration for Higher New Product Performance: A Group Effectiveness Perspective. *Journal of Product Innovation Management*, 27, 554-571.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

O'Leary-Kelly, S.W., & Flores, B.E. (2002). The integration of manufacturing and marketing/sales decisions: impact on organizational performance. *Journal of Operations Management*, 20, 221-240.

Olson, E.M., Walker Jr., O.C., Ruekert, R. W., & Bonner, J. M. (2001). Patterns of cooperation during new product development among marketing, operations and R&D: Implications for project performance. *Journal of Product Innovation Management*, 18, 258-271.

Olson, E.M., Walker Jr., O.C., & Ruekert, R.W. (1995). Organizing for effective new product development: The moderating role of product innovativeness. *Journal of Marketing*, 59(1), 48-62.

Pfeffer, J., & Salancik, G. R. (1978). *The External Control of Organizations*. New York: Harper & Row.

Podsakoff, P.M. MacKenzie, S. B., Lee, J.Y., & Podsakoff, N.P. (2003). Common method biases in behavioural research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88, 879-903.

Rindfleisch, A., & Moorman, C. (2001). The acquisition and utilization of information in new product alliances: A strength-of-ties perspective. *Journal of Marketing*, 65, 1-18.

Rosenkopf, L., & Almeida, P. (2003). Overcoming local search through alliances and mobility. *Management Science*, 49(6), 751-766.

Rothaermel, F. D., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, 25, 201-221.

Ruekert, R.W., & Walker Jr., O.C. (1987). Marketing's Interaction with Other Functional Units: A Conceptual Framework and Empirical Evidence. *Journal of Marketing*, 51, 1-19.

Sherman, J.D., Berkowitz, D., & Souder, W.E. (2005). New Product Development Performance and the Interaction of Cross-Functional Integration and Knowledge Management. *Journal of Product Innovation Management*, 22, 399-411.

Sherman, J.D., Souder, W.E., & Jenssen, S. A. (2000). Differential effects of the primary forms of cross functional integration on product development cycle time. *Journal of Product Innovation Management*, 17, 257-267.

Simonin, B.L. (1997). The importance of collaborative know-how: an empirical test of the learning organization. *Academy of Management Journal*, 40(5), 1150-1174.

Sirmon, D.G., & Lane, P.J. (2004). A model of cultural differences and international alliances performance. *Journal of International Business Studies,* 35, 306-319.

Sivadas, E. & Dwyer, F.R. (2000). An Examination of Organizational Factors Influencing New Product Success in Internal and Alliance-Based Processes. *Journal of Marketing*, 64, 31-49.

Song, M., & Montoya-Weiss, M.M. (2001). The effect of perceived technological uncertainty on Japanese new product development. *Academy of Management Journal,* 44(1), 61-80.

Song, X.M., Neeley, S.M., & Zhao, Y. (1996). Managing R&D-marketing integration in the new product development process. *Industrial Marketing Management,* 25, 545-553.

Song, X.M., & Parry, M.E. (1997). A Cross-National Comparative Study of New Product Development Process: Japan and the United States. *Journal of Marketing,* 81, 1-18.

Song, X.M., & Swink, M. (2002). Marketing-manufacturing joint involvement across stages of new product development: Effects on the success of radical vs. incremental innovations. *Academy of Management Proceedings*, 131-136.

Song, M., & Thieme, R.J. (2006). A cross-national investigation of the R&D marketing interface in the product innovation process. *Industrial Marketing Management*, 35, 308-322.

Song, X.M., Thieme, R. J., & Xie, J. (1998). The Impact of Cross-Functional Joint Involvement Across Product Development Stages: An Exploratory Study. *Journal of Product Innovation Management*, 15, 289-303.

Souder, W.E., & Chakrabarti, A.K. (1978). The R&D-Marketing interface: Results from an empirical study of innovation projects. *IEEE Transactions on Engineering Management*, 25(4), 88-93.

Souder, W.E., & Moenaert, R.K. (1992). Integrating marketing and R&D project personnel within innovation projects: an information uncertainty model. *Journal of Management Studies*, 29 (4), 485-512.

Souder, W.E., Sherman, J.D., & Davis-Cooper, R. (1998). Environmental uncertainty, organizational integration, and new product development effectiveness: a test of contingency model. *Journal of Product Innovation Management*, 15, 520-533.

Souder, W.E., & Song, X. M. (1997). Contingent product design and marketing strategies influencing new product success and failure in U.S. and Japanese Electronics Firms. *Journal of Product Innovation Management*, 14(1), 21-34.

Swink, M.L. (1999). Threats to new product manufacturability and the effects of development team integration processes. *Journal of Operations Management*, 17, 691-709.

Tatikonda, M.V., & Rosenthal, S.R. (2000). Successful execution of product development projects: balancing firmness and flexibility in the innovation process. *Journal of Operations Management*, 18, 401-425.

Tatikonda, M.V., & Montoya-Weiss, M.M. (2001). Integrating Operations and Marketing Perspectives of Product Innovation: The Influence of Organizational Process Factors and Capabilities on Development Performance. *Management Science*, 47(1), 151-172.

Thieme, R.J., Song, X.M., & Shin, G-C. (2003). Project Management Characteristics and New Product Survival. *Journal of Product Innovation Management*, 20, 104-119.

Tushman, M.L., & Rosenkopf, L. (1992). Organizational determinants of technological change: Toward a sociology of technological evolution. *Research in Organizational Behavior*, 14, 311-347.

Van Dierdonck, R., & Miller, J.G. (1980). Designing production planning and control systems. *Journal of Operations Management*, 1(1), 37-46.

Venkatraman, N. (1989). The concept of fit in strategy research: Toward verbal and statistical correspondence. *Academy of Management Review*, 14, 423-444.

Verma, D., & Sinha, K.K. (2002). Toward a theory of project interdependencies in high tech R&D environments. *Journal of Operations Management*, 20, 451-468.

Verona, G. (1999). A Resource-Based View of Product Development. *Academy of Management Review*, 24(1), 132-142.

Zhang, D., Hu, P., & Kotabe, M. (2011). Marketing–Industrial Design Integration in New Product Development: The Case of China. *Journal of Product Innovation Management,* 28, 360-373.