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OEM Participation in SME Suppliers' New Product Development Efforts

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A B S T R A C T

This study examines the effects of product complexity, criticality, and innovativeness on OEM performance when those links are mediated by the original equipment manufacturer (OEM)'s participation in the SME supplier's new product development and moderated by the manufacturer's culture. A cross-sectional sample of 169 purchasing managers from the industrial and commercial machinery, computer, electrical, and transportation equipment industries participated in the study. Respondents completed questionnaires that were delivered via surface mail or email. Both mediation and moderation were examined using standard regression techniques. Results show significant positive relationships between the three different types of product characteristics and manufacturer participation, and significant relationship between manufacturer participation and performance. Results also indicate a moderating role for organizational culture on the relationship between manufacturer participation and NPD performance.

Keywords: Product complexity; Product criticality; Product innovativeness; OEM customer participation

Ⅰ. Introduction

Increasing dynamism in the technological and market environments is making new product development (NPD) more important to the competitive postures of companies in many industries. Increased competition from both domestic and global players, the continuous introduction of new products and processes, and changing customer requirements shorten product life cycles, while rising product development costs enlarge reliance on collaboration in both the NPD process and eventual commercialization (Gupta and Wilemon, 1990; Wheelwright and Clark, 1992). This collaboration takes place not only across units within organizations, but also across channel levels in value creation chains.

Two contexts exist for marketing channel member participation in NPD. Which channel member designs the new product and takes responsibility for the NPD process determines the context. First, a supplier participates in the manufacturer's NPD process, and second, the original equipment manufacturer (OEM) participates in the SME supplier's NPD process. However, most research focuses on the importance of the manufacturers' NPD, with attention to their processes and up-front activities, while there is limited research that focuses on manufacturer participation in suppliers' NPD.

In the competitive environment, suppliers are an increasingly important resource for manufacturers. Because of hard global competition OEM manufacturers place strict demands on their local SME suppliers. Price competition contrives cost reduction pressures for entire supply chain. Thus manufacturers require SME suppliers

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to cut costs and to improve quality and responsiveness.

In addition, SME suppliers have a large and direct impact on cost, quality, technology, speed, and responsiveness of buying companies (Ragatz, Hanfield, and Schnnell, 1997). Effective integration of suppliers into the product value/supply chain will be a key factor for some manufacturers in achieving the improvements necessary to remaining competitive (Nisihkawa, Schreier, and Ogawa, 2013).

However, a significant recent change in business markets has been the increasing involvement of manufacturers in new product development (NPD) processes (Chang and Taylor, 2016; Fang, 2008). The specific context of this research is a manufacturer's (e.g., Ford) involvement in its component supplier's (e.g., sound systems manufacturer) new component development process. Firms such as Ford, BMW, and Boeing rely increasingly upon their suppliers for their contribution to innovative and new product development processes. For example, Boeing's 787 Dreamliner aircraft development included numerous suppliers in a large-scale collaboration. One supplier's suggestion to use composite materials for aircraft construction proved to be a key innovative approach, which led to fundamental changes in the industry (Yeniyurt, Henke and Yalcinkaya, 2014).

OEMs serve as "bridges" between retailers/distributors and component suppliers that transfer market information into the component development process; this bridge is particularly significant in industrial markets in which component manufacturers lack easy access to information about retailers and distributors (Fang, 2008).

This study employs group decision theory and past customer participation research to examine the overall effects of various product characteristics on OEM performance when those links are mediated by manufacturer participation in the SME suppliers' NPD processes.

This study also investigates the change in the relationship between OEM participation and OEM performance due to OEM organizational-culture perceptions. Most customer participation research deals with individual customers rather than organizational customers. However, in a business-to-business (B-to-B) context, most customers represent organizations nested in their unique organizational cultures. Thus, investigating the interaction effects between OEM participation and organizational culture on performance provides insight into organizational customer behavior.

The results of this study indicate significant positive relationships between three different types of product characteristics and OEM participation, and mixed results between OEM participation and performance, suggesting that OEM participation fully mediates the relationship between product characteristics and NPD performance. In addition, an innovative culture moderates OEM participation-NPD performance link. From a managerial standpoint, these findings provide specific guidelines on how to manage OEM participation to improve new product development and speed to market.

First group decision theory is reviewed as a background theory for the study, followed by a presentation of the research model and hypotheses. The methods section describes the sample, data collection procedure, and measurement instrument. Hypothesis testing and a review of results follow. The article closes with key findings, recommendations for future research, and study limitations.

Ⅱ. Background Theory

This research investigates relationships between product characteristics and OEM performance mediated by OEM participation based on group decision theory. First, the effect of OEM participation on OEM performance is predicted by group decision theory itself. Next, effects of product characteristics on OEM participation are explained by task characteristics in decision-making theory.

A. Group Decision Theory

Decisions about important social, organizational, and political issues are frequently made by groups rather than individuals. Using groups to make decisions is often justified on the grounds that groups can bring more intellectual resources to bear on a problem, which in turn should increase the probability that a high-quality decision will result (e.g., Vroom and Jago, 1988). These groups may take the form of committees, expert boards, commissions, project groups, advice teams, think tanks

(Hackman, 1990; Sundstrom, De Meuse, and Futrell, 1990), or multidisciplinary and multifunctional teams (Jackson, 1992). There are two explanations for the advantages of group decision-making (Brodbeck, Rudolf, Andreas, and Stefan, 2007).

First, groups can be perceived as a vehicle for identifying and integrating individual viewpoints. This representative and integrative function permits participation in decision making, which mainly has the beneficial results of higher acceptance and better implementation of a decision. Research has shown that participation in group decision-making increases perceptions of fairness and the acceptance of the decisions made, allows for higher identification with the decision, and results in a stronger commitment to the decisional implications (Moscovici and Doise, 1994; Vroom and Jago, 1988). With regard to this perspective, groups seem to meet expectations.

On the other hand, groups can be viewed as a vehicle for combining and integrating different knowledge, ideas, and perspectives into high-quality decisions and innovations. Compared to individual decision makers, groups have access to more and a broader range of information, which is due to the unique knowledge distributed among group members (Clark and Stephenson, 1989; Hollenbeck, Ilgen, Sego, Hedlund, Major, and Phillips, 1995; Maier, 1963). Therefore, groups are often expected to make high-quality decisions and to foster creativity and innovation (Stasser and Birchmeier, 2003).

Figure 1 shows the group decision-making process can occur in the SME supplier and buyer's relationship, as buyers need more information about discrepancy between what they want to have and what they can get, and how to minimize this difference. On the other hand, suppliers also need to know exactly what buyers want to have to minimize their additional manufacturing cost for revision. As a way of group decision-making, both members want to participate in the NPD process. Thus, based on group decision-making theory, OEM participation in the supplier's NPD process can be explained as a communication method to pool the critical information possessed by various relational members.

One important concept related to group decision-making involves task characteristics. Empirical research has shown that task characteristics constitute important determinants of information processing (Tushman, 1979; Daft and Macintosh, 1981). The main underlying argument is that complex, non-routine, creative tasks tend to set greater information requirements than simple, routine tasks (Tushman, 1978, 1979; Bryce, 1990). This is explained through the tight inter-relation that exists between information processing and varying levels of uncertainty (Bryce, 1990). That is, greater task simplicity and routineness minimizes uncertainty, which in turn reduces information processing requirements (Tushman, 1978; Daft and Macintosh, 1981). According to Perrow's research (1967), high task variety and analyzability tend to trigger greater uncertainty, which in turn affects the amount of information processing

In the supplier and manufacturer relationship, the goal of their exchange is the creation and delivery of the product that the manufacturer desired. Thus, the task characteristics of this relationship can be explained as characteristics

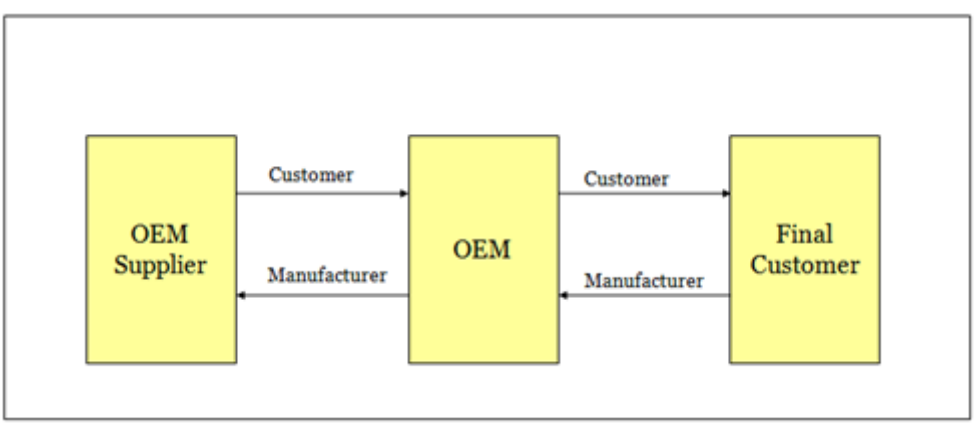

Figure 1. Relational Perspective among Supplier, Manufacturer and Final Customer

of the product. Thus, the focus of this research is on the effect of product characteristics on the customer's participation in the NPD process based on the role of task characteristics in group decision-making.

B. OEM Participation

There are two contexts for marketing channel member participation in NPD. These contexts are delineated in terms of the channel member that is designing the new product and is responsible for performing the NPD process. The first is supplier participation in the NPD process of the OEM. There has been a considerable amount of research into supplier participation in OEM NPD going back at least 40 years, when Myers and Markquis (1969) noted the contribution of supplier participation in OEM NPD to the early resolution of problems in the development process. More recent work has been conducted by Nagati and Rebolledo (2013) and Yeniyurt, Henke and Yalcinkaya (2014). Henke and Zhang (2010) suggested that among potential external partners, suppliers are recognized as an important source of innovation.

But it is the second context that the present study seeks to investigate, the participation of the manufacturer in its supplier's NPD process. "OEM participation" is defined as the extent to which the manufacturer is involved in the supplier's NPD process. The breadth and depth of the OEM participation in the NPD process is crucial in the definition of participation (Fang, Palmatier, and Evans, 2008). Breadth refers to the scope of participation across the product development process and depth represents the customer's level of participation in a phase of the product development process. The level of OEM participation can play a role in the key drivers of new product value creation, the NPD process, and the level of resources invested in the NPD (Dyer and Singh, 1998; Fang, Palmatier, and Evans, 2008).

Researchers have proposed that OEM participation affects a supplier's NPD process by increasing the level of information shared during the NPD process, and by improving how well two firms coordinate their actions during the NPD process (Dyer and Singh, 1998; Larson, 1992). Information-sharing refers to the extent to which two partners effectively exchange critical information about the product idea, market, and competition, among other issues, during the NPD process (Jap, 1999; Van de, Delbecq, and Koenig, 1976). Coordination effectiveness is the extent to which the two partners effectively work together to accomplish a collective set of tasks during the NPD process (Jap, 1999; Van de et al., 1976).

OEM participation enhances both parties' ability to identify what information needs to be shared and how to work more cooperatively. When a customer participates in a supplier's NPD process, each party knows the pertinent knowledge possessed by the other, which helps them evaluate and recognize what information to share and increases the efficiency of their coordination effort (Dyer and Singh, 1998; Larson, 1992). Researchers have found that customers' early involvement in the NPD process and higher levels of social interaction between the parties improve the information intensity, frequency, and breadth (Celly and Frazier, 1996).

Fang (2008) addressed the two distinctive roles of manufacturer participation in the supply chain. First, manufacturer participation serves as an information source that "bridges" between retailers/distributors and component manufacturers market information transfer for the component development process; this bridge is particularly significant in industrial markets in which component manufacturers lack easy access to information about retailers and distributors. Second, OEM participation can go as far as a co-developer and underscores the extent to which the manufacturer's task involvement constitutes a significant portion of the development tasks. When the OEM is involved in the component development process, the overall NPD process becomes a joint problem-solving approach, the outcome of which is determined by the mechanisms used to coordinate the manufacturer and component supplier (Gerwin, 2004; Fang, 2008).

Thus, in this research, various factors of manufacturer participation in the new product development process are empirically identified and their effects on OEM performance determined.

Ⅲ. Research Hypotheses

Several studies on group decision-making suggest that the benefit of group decision-making should be most

evident with complex tasks, since the successful solution of these tasks requires different perspectives (Amason and Schweiger, 1996; Pelled, 1996; Polzer, Milton, and Swann, 2002). Bowers, Pharmer, and Salas (2000) also found that diverse groups outperform homogeneous groups on complex tasks.

In studying the complexity construct and its impact on participation and influence in industrial buying, researchers have examined two general areas: complexity of the purchase situation (e.g., Cyert, Simon, and Trow, 1956; Grashof and Thomas, 1976; Johnston and Bonoma, 1981; Kirsch and Kutschker, 1982; Dadzie, Johnston, Dadzie, and Yoo, 1999) and complexity of the product (e.g., Fisher, 1976; Lilien and Wong, 1984). Product complexity is defined as the extent to which the consumer perceives a product to be difficult to understand or use (Rogers, 1995). A product that offers a large number of options or that involves a large number of steps in its use will typically be seen as more complex (Burnham, Frels, and Mahajan, 2003).

Consumers are likely to perceive higher risks when products are more complex because the difficulty in understanding the product leads to uncertainty, increasing the perception that an unknown negative outcome may occur (Holak and Lehmann, 1990). Similarly, the larger number of attributes associated with complex products makes both information collection and direct comparisons of attributes more costly (Shugan, 1980). A more complex product is also likely to involve a larger number of learned skills or scripts that must be relearned to switch providers (Wernerfelt, 1985). In sum, when customers perceive products as more complex, they perceive higher risk and may participate in the NPD process to get more information and reduce risk. Garrido-Samaniego and Gutierrez-Cillan (2004) also suggest that product complexity is a causal determinant of the levels of participation and influence in the buying center for industrial purchase decisions. This relationship is presented in hypothesis one and depicted graphically in Figure 2 below.

H1: Product complexity is positively related to original equipment manufacturer (OEM) participation in a supplier's specific NPD process.

When the task is to make an important decision, people are generally more diligent in their search for information (Beatty and Smith, 1987; Gilliand, Schmitt, and Wood, 1993) and use more effortful, analytic strategies to evaluate that information (Johnson and Payne, 1985; McAllister, Mitchell, and Beach, 1979). In the case of group decision-making, Larson, Foster-Fishman and Keys (1994) explained that an important decision increased

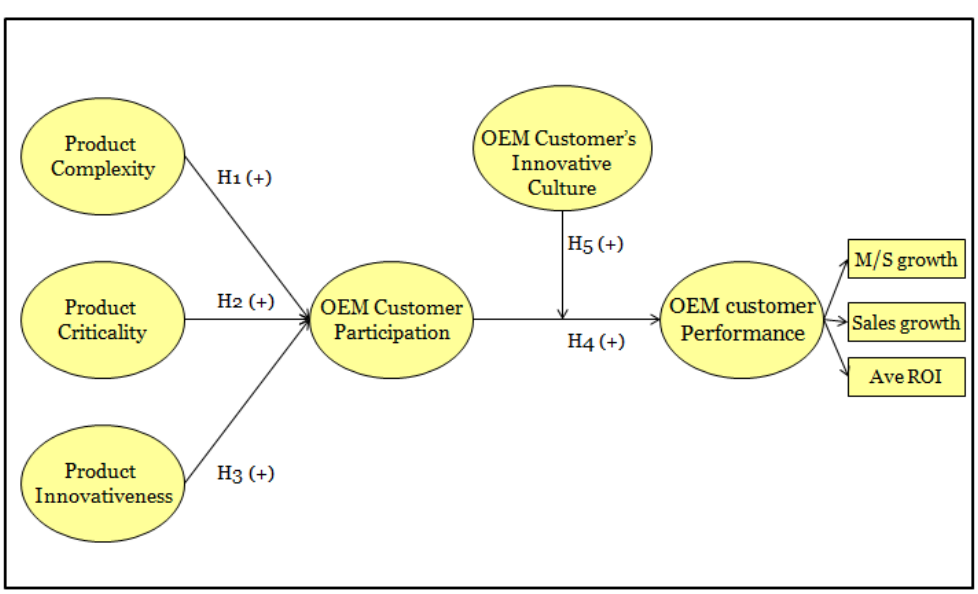

Figure 2. Research Model and Hypotheses

members' motivation to discuss the information they hold because doing so was perceived as benefiting the overall quality of the decision.

Product criticality refers to how important the new product or component is to the purchasing firm. Bello, Lohtia, and Dant (1999) hypothesized that the more critical the component, the more likely it would be for an OEM to collaborate with its vendors in the development of component parts. Cannon and Perreault (1999) used a similar construct that they called "supply importance" and found a significant relationship between the importance of the product and the likelihood of operational linkages and information exchange.

Athaide and Stump (1999) found that bilateral collaboration during successful NPD is more common with customized products. If it is reasonable to believe that a more customized product indicates a more critical product, then it is expected that as a component becomes more critical to an OEM, the OEM is more likely to increase participation in the SME supplier's NPD.

H2: Product criticality is positively related to original equipment manufacturer (OEM) participation in a supplier's specific NPD process.

Product innovativeness in this research refers to the level of newness of the product to the purchasing firm (OEM). Past research on the relationship of product innovativeness to new product success has been inconclusive, though a positive relationship has received the greatest amount of support (Henard and Szymanski, 2001). In the majority of studies, the innovativeness of the product is assessed by the developing firm. In the current study, innovativeness is as perceived by the OEM of the new product.

Olson, Walker, and Ruekert (1995) found that more participative structures contribute to greater effectiveness and timeliness of the development process when the product being developed is more innovative. They note that when the product is more innovative, it creates greater dependencies and the need for greater information flows between the functional areas engaged in the NPD process. Though they did not study customer participation in the development process, the same increased need for participation should be present and lead to a greater likelihood of new product success. Thus it is expected that as product innovativeness increases, OEM participation in a SME supplier's specific NPD process also increases.

H3: Product innovativeness is positively related to original equipment manufacturer (OEM) participation in a suppliers' specific NPD process.

There has been a lot of research explaining the positive relationship between group decision-making and group decision quality. For example, Vroom and Jago (1988) suggest that using groups can bring more intellectual resources to bear on a problem, which in turn should increase the probability that a high-quality decision will result.

Rothwell et al. (1974) offer early insight, through the SAPPHO projects, on the determinants of NPD success. This series of studies concluded that an understanding of manufacturers' needs was the most important discriminator between new product success and failure (Gruner and Homburg, 2000). Cooper and Kleinschmidt (1987; 1988; 1994) conducted a number of studies that link new product success with effective product protocol and the up-front understanding of the manufacturer's needs and preferences. Zirger and Maidique (1990) also found that new product success is greater when the firm has an in-depth understanding of its customers and the marketplace, suggesting that the supplier firm gains beneficial knowledge of its customers' needs and wants through these interactions. The Montoya-Weiss and Calantone (1994) meta-analysis identifies several discriminators of new product success, including the importance of OEM participation in the NPD process.

H4: Original equipment manufacturer (OEM) participation in a supplier's specific NPD process is positively related to OEM performance.

Harris and Mossholder (1996) point out that organizational culture stands as the center from which all other factors of human management derive. It is believed to influence individuals' attitudes concerning outcomes, such as commitment, motivation, morale, and satisfaction. Wallach (1983) has suggested that individual job performance depends on the match between an individual's characteristics and the organizational culture. Odom, Boxx, and Dunn (1990) found that employee attitudes and behaviors are enhanced by an organizational culture

that exhibits innovative characteristics.

An innovative culture is defined as a "style of corporate behavior that is comfortable with, even aggressive about, new ideas, change, risk, and failure"(O'Reilly, 1997, p. 60), and where managers and employees believe in the importance of new products for the company's continued success, domestically and internationally (Smith, 1998). It is a mindset that motivates employees to endorse holistically a belief in creating newness (Kuczmarski, 1988).

Garcia and Calantone's (2002) innovativeness classification framework views industry-level technology and market discontinuities as macro innovativeness, and firm-level technology and market know-how newness as micro indicators of innovativeness. Garcia and Calantone (2002) described microlevel newness as dependent on a firm's capabilities and competencies in marketing and technical areas. Similarly, Danneels and Kleinschmidt (2001) employed the resource-based view of the firm in describing firm innovation as a function of the extent to which existing firm resources and capabilities may be used to develop the marketing and technical aspects necessary for new product development.

Firms with a micro-level innovative culture create an atmosphere in which entrepreneurship (Blau, 1997; Knox, 2002; Wasmer and Bruner, 1991) and risk taking (Barnholt, 1997; Denton, 1998) are encouraged and rewarded. The NPD literature provides ample research-based evidence that an innovative culture has a positive impact on performance. In studies of firms in a variety of industries (Capon, Farley, Lehmann, Hulbert, 1992; Cooper and Kleinschmidt, 1995; de Brentani, 2001), researchers consistently have found a significant positive relationship between the success of the NPD effort and an innovative corporate climate. In a highly innovative culture, an organization may require the collection of information about new customers, the analysis of different customer needs, new service capabilities, and the development of new market research skills. This knowledge helps guide SME suppliers' engineering designs and contributes better technical development and manufacturing process designs. Thus, an innovative culture significantly reduces marketing- and technical-related uncertainties in the NPD process. This discussion suggests hypothesis five.

H5: The greater the original equipment manufacturer (OEM)'s innovative culture, the greater the positive relationship between OEM participation in a supplier's specific NPD process and OEM performance.

Ⅳ. Empirical Test

A. Sampling Frame

To measure the constructs in the proposed model, managers of OEMs were asked to evaluate their perceptions of the characteristics of a new product that was ordered from a SME supplier. The sampling frame consisted of 2,000 names from a list of purchasing professionals as key informants because sales personnel with whom purchasing professionals interact have been shown to be the most important source of customer information, including their desire for and reaction to new products (Gordon, Schoenbachler, Kaminski, and Brouchous, 1997). The sampling frame contained only manufacturing organizations from the two-digit SIC (Standard Industrial Classification) codes 35, 36, and 37 (industrial and commercial machinery and computer equipment; electronic and other electrical equipment and components: and transportation equipment) representing OEMs involved with purchasing new products from SME suppliers (Heide and John, 1990). The SIC is a system for classifying industries by a four-digit code. Established in the United States in 1937, it is used by government agencies to classify industry areas.

Each of the 2,000 key informants was mailed a questionnaire, then, at two subsequent two-week intervals, all non-respondents were mailed a reminder letter. From the total sampling frame, 169 (9.05%) usable responses were received.

To examine the non-response bias, a random sample of 500 non-respondents were phoned and asked to answer a few questions from the survey. Non-response bias also tested by comparing responses from the first and second mailings on each construct. A comparison was made between the first 29 surveys received in the main study and the last 29 surveys received as a result of the phone/fax follow-up. As shown in the Table 1, there were no significant differences between the variables in the study using both techniques, indicating that non-response bias was not a problem.

Table 1. Comparison of Respondents: Estimate of Nonresponse Bias

	Mean		
Variable	First 29	Last 29	*p*-value
Product complexity	6.000	5.448	.021
Product criticality	5.965	5.793	.624
Product innovativeness	4.244	4.209	.920
OEM customer participation	5.791	5.465	.167
NPD performance	5.336	4.957	.649

Respondents were asked to indicate product type, so the product category the respondent addressed in the survey could be identified. These responses were coded into five new product categories: raw or semi-finished material (19.5 % of respondents), operating or maintenance supply (4.1 %), part or component (8.3 %), capital or accessory equipment (56.3 %) and others (11.8 %). Tests on the constructs of interest showed a difference on one construct: customer participation. On this construct, customers in the "part or component" product-type category participated more in the NPD process than customers in the "other" category. The "other" category included all other product types including completed items that might complement an OEM's new product as well as commodity items such as fasteners.

Among the 169 respondents investigated, there were more male respondents (77.2%) than female respondents (22.8%). About 2.5% of the respondents were less than 25 years old, 47.3% of them were between 25 and 39 years old, 42.9% of them were between 40 and 55 years old, and 7.3% of the respondents were more than 56 years old. The most frequent level of education reported by the purchasing professionals was university degree, which accounted for almost 48.5% of the respondents. The second most frequent level of education was high school degree (32.8%), followed by college degree (14.1%).

B. Measurement Scale

Defining product complexity, the construct's purpose is to tap into the technological and service complexity of the product offering. Product complexity was measured with the 4-items which were developed by Solberg (2008). Product criticality refers to how important the new product or component is to the purchasing firm. A scale of supply importance from Cannon and Perreault (1999) was used. The root for this seven-level semantic differential scale is "Compared to other purchases that your firm makes, this product is". 4-items were used. Product innovativeness is defined as newness to the customer. To measure product innovativeness, Atuahene-Gima(1995)'s six-item scale of product innovativeness from the customer's perspective was used. OEM Customer participation refers to the extent to which the OEM customer's task involvement constitutes a significant portion of the development task; three items that use a seven-point Likert scale were developed from Fang (2008). Innovative culture was measured via a 12-item scale. This scale was based on the earlier work of Deshpande' et al. (1993) focusing on key aspects of innovativeness from a cultural perspective, including encouraging creativity, being receptive to new ideas, decentralizing decision-making and encouraging open communication. These items were also measured via a seven-point scale with scale poles ranging from "strongly disagree" to "strongly agree". OEM customer NPD performance was measured by three items tapping the extent to which the new product achieved market share, sales growth and return on investment (ROI). I adopted this scale from prior research (Deshpandé, Farley, and Webster, 1993) Individual measurement items for the constructs are listed in Appendix.

C. Measurement Model and CFA Results

Confirmatory factor analysis of the measurement model resulted in appropriate fit indices (χ^2 = 816.640, df = 419, p < .001, CFI = .938, RMSEA = .066). Based on the confirmatory factor analysis, any item that loaded at less than 0.405 on its latent variable was deleted from the model (Bell, Auh, and Smalley, 2005). As a result, a total of five items were removed from the following

Table 2. Moderated Regression Results

	Model 1			Model 2		
	DV = OEM participation			DV = NPD performance		
	b	(SE)	p-Value	b	(SE)	p-Value
Constant	.006	.587	.010**			
Product complexity: H1	**.527**	**.068**	**.000****			
Product criticality: H2	**.176**	**.065**	**.000****			
Product innovativeness: H3	**.312**	**.100**	**.002****			
Constant				5.168	1.371	.000**
Product complexity				.014	.081	.863
Product criticality				.095	.099	.338
Product innovativeness				.035	.104	.333
OEM participation: H4				**.366**	**.069**	**.000****
Innovative culture				-272	.222	.228
OEM participation X Innovative culture: H5				**.100**	**.047**	**.037***
F					4.453	
R^2					.142	

scales: customer participation, product complexity, product innovativeness, and innovative culture. The fit indices of the revised model were satisfactory (χ^2 = 430.350, df = 237, p < .001), CFI = .951, RMSEA = .067). Composite reliabilities (r > .70) and coefficient alphas (α > .80) were satisfactory.

D. Hypotheses Testing

To directly test the proposed research model as shown in Figure 1, a regression-based path analysis was used with the aid of existing computational tools for estimating and probing interactions and conditional indirect effects in moderated mediation models (Hayes and Matthes, 2009; Preacher et al., 2007). An SPSS macro (Preacher et al., 2007) was utilized to estimate both mediation and moderated mediation models. Results from the mediation model indicated that product complexity was positively associated with OEM participation (β = .527, s.e. = .068, p < .00), product criticality was positively associated with OEM participation (β = .176, s.e. = .065, p < .00), and product innovativeness has positive effect on OEM participation (β = .312, s.e. = .100, p < .05). Thus, Hypothesis 1, 2, and 3 were supported. Result also showed that OEM participation was positively related with NPD performance (β = .366, s.e. = .069, p < .00), which represent hypothesis 4 was significant.

Significant tests for the indirect effects were based on bias-corrected confidence intervals derived from 5,000 bootstrapped samples (Preacher and Hayes, 2008). As shown in the Table 3, the indirect effect of product complexity on NPD performance was partially significant at the average and one standard deviation above the mean of moderator which was manufacturer's innovative culture. At the low level of innovative culture, range of confidence interval included the "0" which represent the indirect effect was not significant. However, indirect effects of product criticality and product innovativeness on NPD performance are all significant. Thus, OEM participation mediated the relationship between product characteristics and NPD performance.

Tables 2 and 3 also summarize the results from the moderated mediation model. Table 2 shows that the interaction of OEM participation with innovative culture was significant in predicting NPD performance (β = .366, s.e. = .069, p < .00). Thus hypothesis 5 was supported.

Ⅴ. Discussion

This research identifies effects of several specific

Table 3. Result of conditional indirect effects.

Constant	Innovative culture	Effect	Boot SE	LLCI	ULCI
Indirect Effect of Product complexity on NPD performance	4.469	.042	.052	-.046	.167
	5.580	.101	.048	.018	.214
	6.691	.159	.060	.061	.306
Indirect Effect of Product criticality on NPD performance	4.469	.151	.043	.249	.076
	5.580	.186	.049	.291	.093
	6.691	.221	.060	.342	.104
Indirect Effect of Product innovativeness on NPD performance	4.469	.285	.081	.146	.465
	5.580	.357	.078	.224	.539
	6.691	.428	.0938	.262	.631

Note. $^{**}p < .01$. $^{*}p < .05$ (two-tailed test).

Measurement items

Construct and Source	CR/AVE/ Cronbach's α	Scales
Product complexity (Solberg 2008)	CR = 0.866 AVE = 0.785 α= 0.881	*Our products that the manufacturer is asking for are characterized…* • By a high degree of complexity. • By a high degree of technological innovation. • By a high degree of specialization. • By a great need for maintenance.
Product criticality (Cannon & Perreault 1999)	CR =0.905 AVE = 0.692 α=0.908	*Compare to other purchase your firm make this product is* • Important—unimportant • Nonessential—essential • High priority—low priority • Insignificant—significant
Product innovativeness Atuahene-Gima(1995)	CR = 0.896 AVE = 0.785 α=0.908	• It required a major learning effort by us. • It took a long time for us to understand its full advantages. • The product concept was difficult for us to evaluate or understand. • It required considerable advance planning for us to use. • It involved high changeover costs. • The product was more complex than we previously used
OEM customer participation (Fang 2008)	CR = 0.902 AVE = 0.649 α=0.910	*During the participation process:* • Manufacturer's development effort played a very important role in the completion of NPD development tasks. • Manufacturer's participatory work constituted a significant portion of the overall NPD development effort • Manufacturer's involvement as co-developer of the component was quite significant.
Innovative culture (Deshpande' et al. 1993)	CR = 0.817 AVE = 0.692 α= 0.830	• Manufacturer's organizational culture was encouraging creativity and innovation • Manufacturer's organizational culture was receptive to new ways of doing things • Manufacturer's organizational culture was allowing individuals to adopt their own approach to the job
New product performance (Deshpande' et al. 1993)	CR = 0.910 AVE = 0.841 α= 0.925	*Please use the following scale to indicate your extent of agreement about how well the new product you selected has performed on each of the performance indicators mentioned below* • Market share growth • Sales growth • ROI

product characteristics on OEM participation in the new product development process of their suppliers and the consequence of OEM customer participation in a B-to-B context. Based on group decision theory, the study shows that product innovativeness, complexity, and criticality are positively related to participation in the NPD process (hypothesis 1, 2, and 3). Thus, when products are highly innovative, complex, and critical to the customer company, OEMs participate more in the product development process. Yet, customer participation sometimes leads to inefficient NPD process and poor NPD performance, this study shows benefit from engaging OEM manufacturers in NPD. Group decision theory appears to be appropriate for explaining the OEM customer participation phenomena, and can be used to expand and encourage understanding about the causes of customer participation in the NPD process.

Next, the mediating effect of participation in the relationship between product characteristics and NPD performances were examined, and participation was found to fully mediate the effect of product characteristics on NPD performance. In the Table 2, results showed that the direct effect of product characteristics (product complexity, criticality and innovativeness) on NPD performance were not significant.

Finally, results show that an innovative culture positively moderates the relationship between OEM participation and NPD performance. Thus, if OEM customer companies have more innovative cultures, participation in SME supplier NPD processes will enhance their NPD performance. Innovative culture is more likely internally-focused and competitive-advantage seeking, since it encourages openness to new ideas and cultivates internally-based capabilities to adopt new ideas, processes, or products successfully (Hurley and Hult, 1998). To enhance OEM capabilities on new product development, innovative OEM should then always participate in their SME supplier's NPD, when products are complex, critical, and innovative. In the table 3, moderated mediation analysis also showed that, as the level of innovative culture goes up, the effects of product criticality, complexity and innovativeness on NPD performance are increased. Thus innovation-oriented organizations continuously develop leading edge positions based on their proactive participation to not only understand supplier's product characteristics but also create new needs of OEM customers.

A. Managerial Implication

Indeed, many forms have found that it difficult to leverage OEM participation towards NPD success. One of possible reason for this is difficult for supplier firms to manage OEM participation because of their diminished managerial discretion and the increased complexity that comes of supplier's objective and OEM's interest. However, improving our knowledge about various factors and benefits about when OEM participation can viably improve NPD performance or should be avoided will be meaningful to managers.

In general, previous research suggests that SME suppliers should always get their customers involved in their NPD process early and often to develop a product that will be successful for the supplier. This research takes the perspective of the OEM, to determine the conditions when an OEM should be involved in a SME supplier's NPD to achieve the best results for the OEM, and thus the SME supplier too.

If the supplier knows when an OEM will most want to be involved in their NPD, they can inform the OEM of the situation and set up the NPD process to include the OEM as an appropriate partner in the NPD process. Thus, knowing that OEMs will perform better if they participate in supplier NPD efforts when the product is complex and critical to the OEM, suppliers can invest in systems to facilitate this participation which should make it more likely that the OEM will want to participate with that particular supplier. Especially in the early stage of new product development process, ideation stage, suppliers can engage OEM manufacturer to obtain their needs-related knowledge, evaluate the potential of new product ideas, and refine and often select promising ideas for further consideration and then render OEM manufacturer to understand the relative importance and complexity of supplier's new product. This situation is enhanced when the OEM's culture is more innovative.

However, in situations where the new product is relatively simple and less critical to the OEM, SME suppliers might do better to survey their OEM customers for general input, but conduct the NPD on their own and attempt to sell the product to their OEM customers after it is market ready.

B. Limitation and Future Research

This research provides empirical evidence of the importance of OEM participation in supplier NPD processes. However, the research also has a few limitations. First, this research focused on product characteristics and culture within organizations. However, environmental characteristics should also be considered as possible causes of participation. For example, competitive intensity or technological turbulence may increase the level of participation in NPD processes.

Specifically, the research focused on the effects of OEM participation on the OEM's performance. Future research might also examine the effects on the SME supplier's performance. OEMs may induce positive or negative results on the supplier's performance. For instance, the OEM's participation may reduce dissatisfaction and increase the OEM's acceptance of new products, enhancing SME supplier performance. However, in the process of new product development, SME suppliers may regard OEM participation as a different type of control and this participation can reduce the speed of NPD and increase the supplier's workload. Thus, OEM participation may influence supplier performance negatively.

In this study, the direct link between OEM participation and OEM performance was examined. Future research might also consider relational consequences such as perceived relationship quality or future intention to repurchase. Future research might investigate other possible moderators that enhance the effect of OEM participation on performance.

In this research, informant subjective performance rating was used. Future research might consider various types of performance rating measures, such as objective performance or supervisor ratings.

With the positive relationship between OEM participation and performance, future research might examine the role of SME supplier sales personnel in initiating and managing the supplier-OEM NPD process.

This research also indicates that OEM managers should work directly on their culture. Future research might examine how various types of organizational cultures (e.g., risk aversion, openness, creativity, and entrepreneurship) and organizational structures affect both supplier and OEM performance.

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