Does Customer Involvement Improve New Product Development Performance?

Yu, Jo-An

<Abstract>

The purpose of this study is to investigate how and to what extent the degree of customer involvement in the early and late stages of product development influences its success. The results indicate that customer involvement enhances product innovation in both the early and late stages of consumer product development, while for industrial product development, the positive effect was found only in the early stage. Further, it was deduced that lead user characteristics have positive effects on the degrees of customer involvement in both the early and late stages and increase customer satisfaction with the industrial product.

<Keywords>

Customer involvement; Stages of product development process; New product development performance; Lead user characteristics
1. Introduction

In recent years, the manner in which firms interact with customers during the process of new product development (NPD) has attracted the interest of researchers and managers. Customer involvement has long been recognized as an important antecedent of innovation. However, there is an obvious inconsistency in the conclusions drawn in the existing literature with respect to how customer involvement affects NPD performance (Table 1). Some studies suggest that customer involvement has a positive effect on NPD performance, while some suggest otherwise.

Customers can provide new ideas and opinions that solidify and evaluate product concepts, and they can facilitate the marketing-R&D interface process as participants (Li and Calantone, 1998). Firms acquire market information and achieve better cost-performance efficiency through frequent and intensive interaction with customers (Maidique and Zirger, 1984). The partnership with customers can also enable firms to attain resources the manufacturer lacks in-house (Athaide et al., 1996), reduce the time and cost required for product development (Bonaccorsi and Lipparini, 1994), and influence product success by affecting product advantages and the quality of the NPD process (Campbell and Cooper, 1999).

Kujala (2003) reviews research on customer involvement in the development of software or computer systems. The study indicates that customer involvement is clearly useful and has positive effects on both system success and customer satisfaction, and developers can determine more accurate user requirements by involving customers. Campbell and Cooper (1999) arrive at a similar conclusion. They propose two major ways in which customer involvement can improve NPD performance: (1) customers can provide critical inputs to improve the quality of innovation, and (2) interacting with customers closely during NPD may facilitate access to development capabilities and other resources that the manufacturer lacks in-house (Campbell and Cooper,
Customer involvement has also been found to be an effective means of cycle-time reduction, R&D technical effectiveness, and R&D commercialization effectiveness (Souder et al., 1998).

In contrast, despite the increased interest in customer involvement in NPD, some evidence suggests that it does not guarantee success (Campbell and Cooper, 1999). Conflicts between development teams and customers could offset the potential economic and technical advantages (Bidault and Cummings, 1994), and interaction with customers may cause dissolving relationships with major clients, bad publicity due to dissemination of premature test results, and acquiring inaccurate or unrepresentative opinions (Dolan and Matthews, 1993). Johne (1994) also indicated the risk that while meeting customers’ needs is a prerequisite for successful product development, it is possible that a business may end up acting as nothing more than a subcontractor for major customers. Challenges to customer involvement manifest in several different ways; this is because the real customers have not been defined until the product is marketed, and interaction with customers may be handled by people not involved in NPD (Grudin, 1991b). As a result, some challenges—such as (1) motivating developers, (2) identifying appropriate customers, (3) obtaining access to customers, (4) motivating potential users, and (5) benefiting from customer involvement—occur when interacting with customers (Grudin, 1991b).

The results derived by Heinbokel et al. (1996) suggest that customer involvement has a negative impact on the features of the process and product quality and leads to low overall success, few innovations, less flexibility, and low team effectiveness.

Thus, it is unclear if customer involvement is beneficial to NPD performance. As summarized in Table 1, previous studies have focused on industrial goods, and only a few studies
identified the stage of NPD. Moreover, the characteristics of the customers involved were not investigated.

This study develops a theoretical framework for the effect of customer involvement on NPD performance, taking into account the NPD stages at which the customers are involved, customer characteristics (‘leaduserness’), and product category (consumer products vs. industrial products). The proposed hypotheses are empirically tested with data collected from 511 Japanese manufacturers between 2007 and 2010.
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<tr>
<th>Study</th>
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<tr>
<td>Maidique and Zirger (1984)</td>
<td>USA electronic industry (success and failure cases, 59 of each)</td>
<td>Firms acquire market information and achieve high cost performance efficiently through the frequent and intensive interaction with customers.</td>
<td>I</td>
<td>N</td>
<td>(+) market information (+) cost performance</td>
</tr>
<tr>
<td>Souder (1988)</td>
<td>53 consumer goods and industrial goods manufacturers and 289 NPD innovation projects</td>
<td>Information on positioning the role of R&amp;D and marketing provided by customer improves product performance.</td>
<td>C and I</td>
<td>N</td>
<td>(+) product performance</td>
</tr>
<tr>
<td>Bonaccorsi and Lipparini</td>
<td>Italian manufacturers of food processing and packaging machine</td>
<td>Partnership with customers reduces time and cost of product developing.</td>
<td>I</td>
<td>N</td>
<td>(+) speed to market (+) NPD cost reduction</td>
</tr>
<tr>
<td>Gales and Mansour-Cole</td>
<td>55 toxic waste treatment projects in United States Environmental Protection Agency (EPA)</td>
<td>A positive relationship exists between user involvement and the success of innovation projects.</td>
<td>I</td>
<td>N</td>
<td>(+) success rate</td>
</tr>
<tr>
<td>Athaide, Meyers, and Wilemon (1996)</td>
<td>High-tech industry, including computer, software, hardware, and automation equipments, etc., in the middle Atlantic states</td>
<td>Partnership with customers enables firms to attain the resources that the manufacturer lacks in-house</td>
<td>C</td>
<td>N</td>
<td>(+) resources</td>
</tr>
<tr>
<td>Li and Calantone (1998)</td>
<td>Software industry in USA</td>
<td>Customers provide new ideas and their opinions that solidify concepts of products, evaluate product concepts, and they can facilitate the marketing- R&amp;D interface process as participants.</td>
<td>C</td>
<td>N</td>
<td>(+) concept identification (+) marketing and R&amp;D cooperation</td>
</tr>
<tr>
<td>Souder, Sherman and Cooper (1998)</td>
<td>American and British high tech companies</td>
<td>Customer involvement should be considered as cycle-time reduction, R&amp;D technical effectiveness or R&amp;D commercialization effectiveness is sought.</td>
<td>C</td>
<td>N</td>
<td>(+) speed to market (+) R&amp;D technical effectiveness</td>
</tr>
<tr>
<td>Campbell and Cooper (1999)</td>
<td>Manufacturers of chemistry, electronic and industrial products</td>
<td>Despite partnership with customer doesn’t have direct effects on product success, it influences product success by affecting product advantages and the</td>
<td>I</td>
<td>N</td>
<td>(+) product advantages (+) NPD process quality</td>
</tr>
<tr>
<td>Author(s)</td>
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</tr>
<tr>
<td>Gruner and Homburg (2000)</td>
<td>Germen machinery industry</td>
<td>Customer involvement in stages of NPD process, except for the engineering stage, has positive effects on NPD success.</td>
<td>I</td>
<td>Y</td>
<td>(+) NPD success</td>
</tr>
<tr>
<td>Kujala (2003)</td>
<td>Projects of computer system development</td>
<td>User involvement has generally positive effects, especially on user satisfaction. Taking it as a primary information source is an effective means of requirement capture.</td>
<td>C</td>
<td>N</td>
<td>(+) customer satisfaction (+) idea generation</td>
</tr>
<tr>
<td>Eric (Er) Fang (2008)</td>
<td>Component manufacturers and OEM customers in the industries of general machinery, electrical and electronic machinery and transportation equipment</td>
<td>The effects of customer participation on product innovativeness and speed to market depend on downstream customer network connectivity and complexity of development process.</td>
<td>I</td>
<td>N</td>
<td>(+/-) product innovativeness (+/-) speed to market</td>
</tr>
<tr>
<td>Grudin (1991b)</td>
<td>Human-computer interface design projects in large product development organizations</td>
<td>From the point of view that customer involvement is necessary: interacting with customers brings new challenges to NPD teams and may hinder NPD success.</td>
<td>C</td>
<td>N</td>
<td>(-) new challenges to NPD teams</td>
</tr>
<tr>
<td>Bidault and Cummings (1994)</td>
<td></td>
<td>Conflicts between develop teams and customer could offset the economic and technical advantages.</td>
<td>--</td>
<td>N</td>
<td>(-) economic advantages (+) technical advantages</td>
</tr>
<tr>
<td>Dolan and Matthews (1993)</td>
<td>Computer industry</td>
<td>Customer involvement may cause dissolving relationships with major clients, ill publicity due to dissemination of premature test results, and acquiring inaccurate or unrepresentative opinions.</td>
<td>C</td>
<td>N</td>
<td>(+) relationship with clients (-) publicity (-) accuracy of customer needs</td>
</tr>
<tr>
<td>Heinbokel et al. (1996)</td>
<td>Computer software development projects conducted in Germany and Germen-speaking Switzerland</td>
<td>Customer involvement has a negative impact on the features of the process and product quality and led to low overall success, few innovations, less flexibility, and low team effectiveness.</td>
<td>C</td>
<td>N</td>
<td>(-) overall success</td>
</tr>
</tbody>
</table>
2. Theoretical Framework

Because of the lack of consensus in the existing research on the effects of customer involvement on NPD performance and how lead user characteristics affect the extent of customer involvement, the conceptual framework (Figure 1) of the present study is derived from Gruner and Homborg (2000) with some modifications, including the following elements: customer involvement in the early stage (including idea generation, opportunity identification, and idea selection) and the late stage (prototyping) of the NPD process, NPD performance, and lead user characteristics.

![Figure 1. The Conceptual Framework](image)

1) NPD Performance

Three NPD performance metrics are employed in this study. *Speed to market* (Griffin, 1997) refers to the length of time it takes from the beginning of NPD until the product launch. *Product innovativeness* is operationalized by asking respondents to compare their products with those of
competing firms and rate the innovativeness of the product function and performance. Griffin and Page (1996) indicated customer satisfaction/acceptance is one of the most useful measurements of product performance in the market. A two-item, five-point Likert scale is used to measure customer satisfaction.

2) The Roles of Customers

Most studies on relationship marketing discuss customer involvement in NPD; however, the concept has not been clearly defined (Kujala, 2003). In the current study, it is defined using the explanation provided by Tyre (1989)—developers communicate and exchange solutions to users’ needs and potential problems with future users.

The forms of customer involvement can be broadly characterized as being on the continuum representing the extent of customer involvement in development (Damodaran, 1996). Customer involvement can be divided into three types: informative, consultative, and participative, describing the roles customers play when customer involvement is low, average, and high, respectively.

Customer involvement also can be distinguished by the roles customers play. Gersuny and Rosengren (1973) identified potential customer roles as resource, worker (co-producer), buyer, and beneficiary (user). Further, customers can be the outcome (product) of transformation activities (Lengnick-Hall, 1996). The roles of buyer, user, and product are classified at the output of organization activity, while the roles of resource and co-producer (also known as information provider and co-developer) (Fang, 2008) are classified at the input side and are closely related to product development (Lengnick-Hall, 1996). The former roles include providing information to organizations during the NPD process. In this dimension, the customers’ role is usually bound to
the start or the end of the NPD cycle. Customers are allowed to make suggestions for their needs, or incremental changes to a prototype. In this role, customers usually act in a reactive mode of responding to questions posted by the manufacturers (Magilo and Baumol, 2010). In contrast, co-developers take part in product development from the beginning of the NPD process, and their task involvement constitutes a significant portion of the development tasks (Fang, 2008).

3) Stages in the New Product Development Process

Even though previous studies have revealed how customer involvement in the product development process influences performance, the product development stage at which customers are involved also needs to be considered (Saren, 1984). However, according to our knowledge, few studies have identified the product stage. Cooper (1979b) adapted a stage-specific aspect of customer involvement in a theoretical model and indicated that prototype testing with customers and users is positively related to product development success. The concept was extensively examined by Gruner and Homburg (2000) using a sample of German industrial product development projects and dividing the NPD process into the stages of idea generation, product concept development, project definition, engineering, and prototype testing. The results indicated that, customer involvement stages except engineering had positive effects on product success. However, the above information is specific to industrial product development. In consumer product development, the intermediate roles and stages of the NPD process remain unexplored.

In this study, the NPD process is divided into a similar set of five stages: idea generation, opportunity identification and idea selection, product design, engineering, and prototyping. In order to eliminate differences caused by the ways in which the practice of new product development differs between industrial and consumer product development—industrial product
customers may participate in the product design and engineering stages, but few consumer product customers do—the product design and engineering stages are excluded and attention is focused on the early stage, which includes idea generation along with opportunity identification and idea selection, and the late stage: prototyping.

4) Information Possessed by Customers

‘To solve a problem, needed information and problem solving capabilities must be brought together (von Hippel, 1994)’. It is helpful to take into account the information manufacturers and customers possess. In typical marketing research, firms try to collect needs-related information from customers, and then develop products that satisfy customers’ needs using their technological knowledge. As this simple example shows, manufacturers possess technological knowledge, and customers possess information on their needs. Von Hippel (1994) pointed out that sometimes proving needs information is costly. By interacting with customers, firms can receive major input that can improve the quality of innovation and facilitate access to development capabilities (Campbell and Cooper, 1999; Li and Calantone, 1998) and other resources that the manufacturer lacks in-house (Athaide et al., 1996), and thus save time and money spent on NPD (Bonaccorsi and Lipparini, 1994). Maidique and Zirger (1984) had a similar viewpoint: Market information is readily available and better cost performance could be attained if companies were to interact intensively with customers. Because of information stickiness, interacting with customers directly reduces the costs incurred when information is transferred from customers to developers (von Hippel, 1994)

In the NPD process, needs-related information is utilized at the early stage to develop a product concept. Thus, customer involvement should have a positive impact on NPD
performance, especially when there is early-stage involvement.

5) Product Category

Most research on customer involvement has focused on industrial product categories, where customer firms possess professional knowledge, and thus cooperation with firms is easier. On the other hand, limited attention has been given to customer involvement in consumer products (Bendapudi and Leone, 2003). According to Olson and Bakke (2001), research on customer involvement in consumer products has mainly been conducted in the field of high-technology products, and it is unclear whether the findings are valid for other consumer products.

Furthermore, compared with consumer product development, developers work more closely, or more intensively, with their customers in industrial product development. Thus, customer involvement effects on product development performance may be more substantial in industrial product development than in consumer product development. However, from the information possession view, it is necessary to take into account customer differences in the industrial goods and consumer goods industries. In the former category customers are firms, while in the latter customers are consumers. In general, knowledge distance in needs-related information is greater between the focal firm and consumers than between the focal firm and customer firms. Thus, customer involvement should have a positive impact on product innovativeness, and its magnitude will be larger in consumer products. Likewise, technological knowledge distance for related information is greater between the focal firm and consumers than between the focal firm and customer firms. Thus, the positive impact of customer involvement on NPD speed is larger in industrial goods industries than in consumer goods industries.
These understandings imply that customer involvement in the idea generation stage can improve the efficiency of NPD and thereby improve the speed to market (H1-1/H1-4: +).

H1-1/H1-4: Customer involvement in the early/late stage has positive effects on speed to market. Effects are stronger for industrial product development.

With regard to innovativeness, the external perspective may be different from the internal; therefore, an outsider may provide additional innovative ideas not provided by someone involved in the NPD process (H1-2/H1-5: +).

H1-2/H1-5: Customer involvement in the early/late stage has positive effects on product innovativeness. Effects are stronger for industrial product development.

The ideas generated on the basis of the customers’ opinions represent market needs, implying developers can determine more accurate user requirements (Kujala, 2003), develop products in keeping with customers’ opinions, and thus lead to an increase in customer satisfaction (H1-3/H1-6: +).

H1-3/H1-6: Customer involvement in the early/late stage has positive effects on customer satisfaction. Effects are stronger for industrial product development.
7) Lead User Characteristics

The literature on user innovation (Urban and von Hippel, 1998; Lilien et al. 2002) suggests that closely interacting with customers and users during the NPD process can shorten the period of NPD and improve customer satisfaction (Herstatt and von Hippel, 1992) and innovation performance (Urban and von Hippel, 1998).

The concept of lead users was developed by von Hippel (1986), who defined them as follows: ‘Lead users face needs that will be general in a marketplace—but face them months or years before the bulk of that marketplace encounters them,’ and ‘Lead users are positioned to benefit significantly by obtaining a solution to those needs’ (von Hippel, 1986). The same research suggests a four-step process for utilizing lead users in marketing research: (1) identify an important market or technical trend; (2) identify lead users in terms of (a) experience and (b) intensity of need; (3) analyze lead user needs data; (4) project lead user data onto the general market (von Hippel, 1986). This process has been adapted in the literature on user innovation to test various product fields, for example, high-technology products (computer-aided systems for the design of printed circuit boards; Urban and von Hippel, 1988) and firms (Olson and Bakke, 2001), pipe hangers used in commercial and industrial buildings (Herstatt and von Hippel, 1992), sporting equipment (Shah, 2000), and major product lines for 3M divisions (Lilien et al., 2002).

These understandings imply that customer involvement can improve the performance of speed to market (H2-1), product innovativeness (H2-2), and customer satisfaction (H2-3).

H2-1: Lead user characteristics have positive effects on speed to market. The effects are stronger for industrial product development.
H2-2: Lead user characteristics have positive effects on product innovativeness. The effects are stronger for industrial product development.

H2-3: Lead user characteristics have positive effects on customer satisfaction. The effects are stronger for industrial product development.

3. Method

1) Measurement Scale

This study employed the secondary data analysis approach. A series of surveys on product development among Japanese product development were conducted since 2007 (Ma et al., 2007; Yu et al., 2008; Hamaoka, 2010, 2011). The constructs and measures are listed in Appendix I.

For example, speed to market (Griffin, 1997) refers to the length of time it takes from the beginning of NPD until the product launch. It is measured here using a three-item, five-point Likert scale. The scale items asked the respondents to rate their speed of development relative to other competing firms.

The measure of product innovativeness used a two-item, five-point Likert scale, and asked the respondents to compare their products with those of competitive firms and rate the innovativeness of the product function and performance and the success rate of new products.

Griffin and Page (1996) indicated that customer satisfaction/acceptance is one of the most useful measurements of product performances in the market. A two-item, five-point Likert scale is used to measure customer satisfaction.

2) Data Collection
Firms were randomly selected from manufacturers with NPD department, which are listed on the Japanese stock exchange. Each year, around 650 questionnaires were mailed to managers of NPD department each year and the approximately 120 responses were received. In a period of four years, a total of 511 responses were received (including multiple-year responses)\(^1\).

4. Results

1) Measurement Validity

The Cronbach’s alpha index (Cronbach, 1951) of reliability exceeds 0.6; this indicates that the reliabilities for the constructs are acceptable. The intended constructs were extracted through exploratory factor analysis and then confirmed with confirmatory factor analysis. Thus, we confirmed the internal consistency and discriminant validity of the measurement.

2) Estimation

In order to test the proposed hypotheses, structural equation modeling (SEM) was used to estimate the model. A multiple group approach was used to test the difference between consumer products and industrial products. The goodness-of-fit statistics of estimated models are summarized in Table 2. As reported in Table 2, four models were estimated. A configural model

\(^{1}\) The sample, response, and response rate for each year are presented below. Details of the survey method and results are available in Ma et al. (2007), Yu et al. (2008), and Hamaoka (2010 and 2011).

<table>
<thead>
<tr>
<th>Year</th>
<th>Questionnaire Mailed</th>
<th>Questionnaire Received</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>616</td>
<td>151</td>
<td>24.7%</td>
</tr>
<tr>
<td>2008</td>
<td>646</td>
<td>124</td>
<td>23.4%</td>
</tr>
<tr>
<td>2009</td>
<td>631</td>
<td>103</td>
<td>/16.3%</td>
</tr>
<tr>
<td>2010</td>
<td>678</td>
<td>133</td>
<td>19.6%</td>
</tr>
<tr>
<td>Total:</td>
<td>2571</td>
<td>511</td>
<td>19.9%</td>
</tr>
</tbody>
</table>
was estimated with no constraints across groups of consumer products development and industrial product development added, while measurement model assumed the factor loadings are the same between two groups. The fits of both of these models are good (RMSEA = 0.028 for both models). Next, structural model (A) assumes the casual paths of the two groups are invariant, and the model fit is also satisfactory (RMSEA=0.027). However, some large modification indexes were obtained for some parameters, thus structural model (B) was derived from structural model (A) by removing equality constraints of H1-4, H1-5, and all hypotheses of H2, and adding some paths to the original model. As indicated in Table 2, structural model (B) has the best goodness-of-fit over other models.

Table 2. The overall model fit of multi-group analysis

<table>
<thead>
<tr>
<th>Model Description</th>
<th>Configurual Model</th>
<th>Measurement Model</th>
<th>Structural Model (A)</th>
<th>Structural Model (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi- square</td>
<td>226.297</td>
<td>239.190</td>
<td>262.742</td>
<td>244.030</td>
</tr>
<tr>
<td>Degree of freedom</td>
<td>154</td>
<td>163</td>
<td>176</td>
<td>171</td>
</tr>
<tr>
<td>P-value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>GFI</td>
<td>0.952</td>
<td>0.950</td>
<td>0.945</td>
<td>0.949</td>
</tr>
<tr>
<td>AGFI</td>
<td>0.926</td>
<td>0.926</td>
<td>0.926</td>
<td>0.929</td>
</tr>
<tr>
<td>CFI</td>
<td>0.977</td>
<td>0.976</td>
<td>0.973</td>
<td>0.977</td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.028</td>
<td>0.028</td>
<td>0.029</td>
<td>0.027</td>
</tr>
<tr>
<td>AIC</td>
<td>398.297</td>
<td>393.190</td>
<td>390.742</td>
<td>382.030</td>
</tr>
<tr>
<td>BIC</td>
<td>776.712</td>
<td>772.010</td>
<td>672.358</td>
<td>685.648</td>
</tr>
</tbody>
</table>
3) Customer Involvement and Product Development Performance

The proposed hypotheses were tested on the basis of structural model (B), and the direct effects are summarized in Figure 2.

H1-1 to H1-3 predicted that customer involvement in the early stage would affect speed to market (H1-1), product innovativeness (H1-2), and customer satisfaction (H1-3) positively. While H1-2 is supported (H1-2: $\beta = 0.181$, $p < 0.001$), H1-1 and H1-3 are rejected (H1-1: $\beta = -0.015$, n.s.; H1-3: $\beta = -0.005$, n.s.). This result suggests that customer involvement in the early stage of the NPD process has a positive effect on product innovativeness and no significant effects on speed to market and customer satisfaction, meaning there is no difference in the effects of customer involvement in the early stage between consumer product development and industrial product development.

When it comes to the late stage of the NPD process, the hypothesis on speed to market is rejected due to the negative relationship found in consumer product development and the insignificant relationship found in industrial product development (H1-4: $\beta = -0.0197$, $p < 0.05$; $\beta = 0.076$, n.s.). The hypothesis on product innovativeness is partially supported by the positive relationship discovered in the development of consumer products; however, it is rejected in industrial product development (H1-5: $\beta = 0.210$, $p < 0.01$; $\beta = -0.080$, n.s.).

Hypotheses 2 predicted that lead user characteristics would have positive effects on speed to market (H2-1), product innovativeness (H2-2), and customer satisfaction (H2-3) in both consumer and industrial product development. As Figure 2 indicates, lead user characteristics demonstrate a significant negative effect on speed to market in NPD of consumer products and no significant effect when developing industrial products (H2-1: $\beta = -0.080$, $p < 0.1$; $\beta = -0.043$, n.s.). H2-2 is also not supported, as there was no significant effect found for development of
either consumer or industrial products (H2-2: $\beta = 0.082$, n.s.; $\beta = 0.034$, n.s.). H2-3 is rejected for consumer product development but supported for NPD of industrial products (H2-3: $\beta = 0.043$, n.s.; $\beta = 1.123$, p < 0.05), indicating that lead user characteristics affect customer satisfaction positively when developing industrial products but insignificantly in consumer product development.

Finally, the effects of lead user characteristics become positive on customer involvement in both the early stage ($\beta = 0.404$, p < 0.001) and the late stage ($\beta = 0.235$, p < 0.001) of the NPD process, regardless of the type of product (Figure 2).

4) Additional Paths

SEM software provides a modification index. Based on this output, we added some paths to our original model. Two of these are from product innovativeness: to speed to market ($\beta = 0.790$, p < 0.001), and to customer satisfaction ($\beta = 0.551$, p < 0.001). This finding suggests that product innovativeness could be regarded as an intermediary between lead user characteristics and speed to market as well as between lead user characteristics and customer satisfaction. The other two paths are from lead user characteristics to customer involvement in the early and late stages of the NPD process. The effects are positive in both the early stage ($\beta = 0.404$; p < 0.001) and the late stage ($\beta = 0.404$; p < 0.001), regardless of the type of product.
4. Discussion

1) Theoretical implications

While the existing literature on customer involvement in the NPD process states that it has certain effects on product success, little empirical evidence exists to shed light on the differences in those effects between consumer and industrial products, or for different stages in the NPD process. The present study offers more specific insights with regard to the methods of testing the impact of customer involvement during the early and late stages of the NPD process by focusing on the effect of the degree of customer involvement, including lead user characteristics of involved customers, on product performance: speed to market, product innovativeness, and customer satisfaction. In line with the testing results, distinctions can be made for the NPD
process between consumer and industrial products. The major findings, their implications, and limitations are discussed in this section.

Table 3. Total Effect of Lead User Characteristics

<table>
<thead>
<tr>
<th>Lead user characteristics</th>
<th>Product Innovativeness</th>
<th>Speed to Market</th>
<th>Customer Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.204/ 0.089</td>
<td>0.029/ 0.039</td>
<td>0.156/ 0.175</td>
</tr>
</tbody>
</table>

(Coefficient of consumer product/ industrial product)

Customer involvement and product development performance

When customer involvement occurs in the early stage of the product development process, it has a positive effect on product innovativeness in both consumer and industrial product development, implying customer involvement in the early stage plays an important role in assisting early identification of applications provided by technology (Cooper and Kleinschmidt, 1993), thereby improving product innovativeness. In the late stage, the positive effect only exists for consumer product development, while the effect for the development of industrial products is insignificant, insinuating the dissimilarity between the NPD of consumer products and industrial products. A possible explanation may be that the roles of involved customers are not identical, generating different effects in the two types of product development. The roles customers assume could be described as information providers and co-developers (Lengnick-Hall, 1996; Fang,
2008). When customers serve as information providers, the type of market information depends on which groups customers belong to and to what extent they interact with each other, in other words, network connectivity (Burt, 2001). High network connectivity restricts customers to local knowledge, hindering the exposure to diverse preferences, causing the information generated not to reflect overall market needs, thus undermining product innovativeness. Another explanation may be that customers involved in industrial product development usually function as co-developers, who interact and share information with manufacturers from the early stage of NPD. Participating as co-developers in the late stage provides only minor improvements of new products, which is not guaranteed to contribute to major technology improvement and hence has little bearing on the innovativeness of products.

The result also indicates that customer involvement in the early stage has no significant effects on speed to market, and most speed-to-market effects are also insignificant in the late stage; however, speed to market is affected negatively in consumer product development. This can also be explained by the roles of the involved customers and network connectivity. As mentioned above, when customers serve as information providers, high network connectivity may harm the accuracy of the provided information on market needs, mislead the direction of development, and consequently undermine the effect on customer satisfaction. On the other hand, co-developing with customers makes the task of product development a joint problem-solving process (Gerwin, 2004; Fang, 2008). The more important the input of both customers and manufacturers for completing each task, the more difficult it is to segregate development into subsequent steps (Fang, 2008). This kind of process interdependence (von Hippel, 1990) raises the necessity for customers and manufacturers to interact and learn from each other (Sobrero and Roberts, 2001), which may increase opportunities to create cutting-edge ideas but also lengthen
the pre-launch period and thus hinder speed-to-market initiatives.

Lead user characteristics and product development performance

Lead user characteristics among participating customers are found to enhance customer satisfaction in industrial product development but have no significant effect on product innovativeness and speed to market; when applied to consumer product development, they do not have significant effects on customer satisfaction and product innovativeness and decrease products’ speed to market. One possible explanation is that there are only very few lead users, as most lead users are experts within specific fields. It may take significant time for product developers to identify lead users (Olson and Bakke, 2001). Moreover, lead users face needs months or even years ahead of more general customers. It may be difficult for general users to accept the ideas provided by lead users, as they are usually novel or too innovative (Urban and von Hippel, 1988).

New findings

Although not formally hypothesized, the direct effects of lead user characteristics on customer involvement in both the early and late stages appear to be positive. These effects suggest that in both consumer and industrial product development, customers or users with lead user characteristics raise the willingness of product developers to interact with them due to the ability to foresee market needs and the solutions to those needs. Especially in the early stage of product development, where ideas and the accuracy of information about market needs are crucial, lead user characteristics play the important role of helping product developers define explicit concepts for products.
Moreover, two other direct effects of product innovativeness are found despite the fact that their paths are not formally hypothesized—one impacts speed to market and the other impacts customer satisfaction. Both are positive and significant, which implies that regardless of the fact that customer involvement in the early and late stages of NPD does not have direct effects on speed to market and customer satisfaction, it still affects these two performances indirectly by improving product innovativeness. The result is in accordance with previous studies, indicating that high customer satisfaction can be achieved by improving product innovativeness. Moreover, contrary to some previous studies, the result suggests high product innovativeness can lead to faster speed to market. One possible explanation is that the ideas generated from customers with lead user characteristics may provide product developers with novel methods that may create a new workflow to avoid routine work and thus save development time. Another explanation would be that the positive relationship between product innovativeness and speed to market corresponds with the respondent firms’ product development ability—firms that develop more innovative products can also complete product development in less time—because the respondents to the surveys are managers of departments that are engaged in product development.

According to the results, lead user characteristics do not have direct effects on speed to market, product innovativeness, and customer satisfaction, but they still improve these three performances in indirect ways in terms of total effects. As shown in Table 3, lead user characteristics affect product innovativeness the most among the three performances, followed by customer satisfaction and speed to market. Although customers with lead user characteristics may provide novel methods to avoid routine work and help shorten development time, having customers involved in product development is time consuming, from the search for appropriate participants to communicating with and learning from them until conclusions are reached. The
need to overcome the challenges in motivating the developers and benefiting from customer involvement (Grudin, 1991b) may also undermine the positive effects of lead user characteristics on speed to market. Furthermore, as indicated by von Hippel (1994), ‘when technical information that is costly to acquire, transfer, and use is held in one locus of sticky information, innovation-related problem solving activities will tend to move to that locus.’ The stickiness of information that customers offer can be considered a possible cause of delay in product development. Moreover, as shown in Table 3, the effects on speed to market and customer satisfaction are stronger for industrial product development, while those on product innovativeness are stronger when developing consumer products.

Interaction effect in Lead user characteristics

A simple slope analysis\(^2\) (Aiken and West, 1991) was conducted in order to further understand how lead user characteristics influence speed to market under the circumstances of different product types and stages of NPD, that is, to find the moderation of lead user characteristics between the extent of customer involvement in the early/late stage and the performance of speed to market.

The results reveal the extent to which customer involvement in the early/late stage of NPD moderates the effects of lead user characteristics on speed to market, indicating that all effects are significant except for those in the early stage of consumer product development(\(\beta =0.059;\) n.s.), implying that when the extent of customer involvement is high, lead user characteristics positively moderate speed to market; however, the effects are negative when the extent of customer involvement is low, regardless of the stages of product development process and

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\(^2\) Slope analysis is used to test whether there is a significant linear relationship between an independent variable and a dependent variable, and focused on the slope of the regression line (Aiken and West, 1991).
product types (Figure 3).

Figure 3. Moderating Effects of Lead User Characteristics
In this study, some differences between the development of consumer and industrial products, and between the early and late stages of NPD are recognized. First, in terms of the differences between types of products, lead user characteristics have significant positive effects on customer satisfaction in the development of industrial products, while product innovativeness grows with the extent of customer involvement in the late stage of consumer product development. On the other hand, with regard to the differences between stages, lead user characteristics encourage more customer involvement in the early stage than in the late stage of NPD, which implies that developers are more willing to interact with customers with lead user characteristics in the early stage than the late stage of NPD due to the generation of useful product concepts that help produce ‘breakthroughs’ in product lines (Lilien et al., 2002). Moreover, although the extent of customer involvement in the early stage is positively related to product innovativeness in both types of product development, in the late stage, the significant positive relationship exists only for NPD of consumer products. In other words, in industrial product development, customer involvement in the late stage has no significant effect on product innovativeness.

2) Managerial implications

Product innovativeness, customer satisfaction, and speed to market are three of the most important and useful indices for evaluating product success. Improving them is a crucial objective for product developers. This study suggests involving customers in the stages of the NPD process while bearing in mind the type of product and the aim of product development.

In the development of both consumer products and industrial products, the higher the extent of customer involvement in the early stage, the better the product innovativeness. This suggests that early involvement of customers is indispensable in order to develop novel products (Neale
and Corkindale, 1998).

The findings of this study suggest that in consumer product development, customer involvement in the late stage improves product innovativeness. On the other hand, in the development of industrial products, customers with lead user characteristics help product developers achieve high customer satisfaction performance, implying that the technical knowledge in industrial product development is difficult for general users to understand, making the role of customers with lead user characteristics more important than in consumer product development. Although lead user characteristics do not have a significant effect on performances for consumer products, it can be deduced that the key factor of developing innovative consumer products is not to involve customers only early but also in-depth.

Finally, the results also suggest that when the extent of customer involvement in NPD is high, customers who score high for lead user characteristics are eligible participants if improving speed to market is one of the objectives of product development, while those who score low are suitable participants in developing products with a low extent of customer involvement.

3) Limitations

The results have significant implications for product developers as this study offers guidance regarding the stages of the NPD process at which the firm should involve customers, bearing in mind the type of product and the purposes behind NPD. It is believed that the findings of this study will improve the comprehension of customer involvement. However, this study is incomplete but lays the foundation for further research.

First, as Leonard-Barton (1995) suggested, the characteristics of the involved customers may be a factor of product success, since the activities of customer participation may be influenced by
personal experience and psychology (Fang, 2008). However, this study adapted only lead user characteristics as factors representing the variance of participants. Other characteristics of customers, called personal traits, need to be taken into account, for instance, the social position of brokers (Burt, 2004; 2010); personal values relevant to innovation or creativity—self-transcendence vs. self-enhancement; openness to change vs. conservation (Schwartz, 1992; Steenkamp et al., 1999); and other characteristics such as commitment to product field, innovation-related core benefit, and expected financial benefit (Luthje, 2002). Extending the spectrum of customer characteristics may provide further comprehension of customer participation.

Second, as mentioned in the section on theoretical implication, the interdependence of the stages of the NPD process (Sobrero and Roberts, 2001; Carlile and Rebentisch, 2003; Fang, 2008), the role customers play in NPD—information providers or co-developers (Lengnick-Hall, 1996; Fang, 2008), and the connectivity of the networks to which customers belong (Gargiula and Benassi, 2000; Rindfleisch and Moorman, 2001; Fang, 2008), constitute dominant factors in the evaluation of customer involvement. An extension of the model containing these factors would lead to deeper insights regarding customer involvement.
References


## Appendix I: Scale Items

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Items</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead User Characteristics</td>
<td>Our users are knowledgeable.</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>Our users are technologically advanced.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>We have users whose needs are extremely advanced.</td>
<td></td>
</tr>
<tr>
<td>The Early Stage of Product</td>
<td>Our users inform us.</td>
<td>0.54</td>
</tr>
<tr>
<td>Development Process</td>
<td>Our users often propose new product ideas.</td>
<td></td>
</tr>
<tr>
<td>The Late Stage of Product</td>
<td>Customers involves in the whole product development cycle.</td>
<td></td>
</tr>
<tr>
<td>Development Process</td>
<td>Final product specifications are determined based on the results of field testing.</td>
<td>0.60</td>
</tr>
<tr>
<td>Speed to Market</td>
<td>We execute product development faster than others in the same industry.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>We introduce more new products than others in the same industry.</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>We introduce new products earlier than others in the same industry.</td>
<td></td>
</tr>
<tr>
<td>Product Innovativeness</td>
<td>We have more innovative products than others in the same industry.</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>We suggest new uses for existing products.</td>
<td></td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>The quality of our products is higher compared with others in the same industry.</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>We achieve higher customer satisfaction compared with others in the same industry.</td>
<td></td>
</tr>
</tbody>
</table>