



The Simultaneous Impact of Supplier and Customer Involvement on New Product Performance

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Abstract

The recall rates of various products these years have triggered a new round of interests in the impacts of supplier involvement (SI) and customer involvement (CI) on new product performance (NPP). However, existing literature looks at either SI or CI but not both. Most supply chain management papers focus on SI and NPP while research in marketing field focuses on CI and NPP. Additionally, the NPP has not been elaborated into detail dimensions in these previous studies. This research investigates the impact of both SI and CI on the three dimensions of NPP, namely new product quality and reliability, time to market and product innovativeness. The research was based on the data from over 600 manufacturers in 21 countries. Structural equation modeling (SEM) is used to test the simultaneous impact of SI and CI on NPP. The results show that SI influences all the three dimensions of NPP while CI influences quality and reliability. The research also reveals that companies pay more attention to CI than SI. It seems that more efforts in both academic and practical fields are needed to enhance SI in relation to NPP. The research suggests that both SI and CI should be implemented in new product development process. It is not a two-party issue but a three-party-issue.

Keywords: supplier involvement; customer involvement; new product performance; quality and reliability; time to market; product innovativeness.

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Introduction

New product performance (NPP) is essential to manufacturing companies because it can provide potential implication in company's growth and success (Molina-Castillo & Munuera-Alemán, 2009b). NPP can help firms select a new product launch strategy decisions (Chiu *et al.*, 2006), lead to new product market success (Millson and Wilemon, 2006), and improve the financial performance and firm value (Pauwels *et al.*, 2004). Factors influencing NPP are various along the process of new product development (NPD). Among others, supplier involvement (SI) and customer involvement (CI) start to attract more attention in both NPD and supply chain management (SCM) fields. However, there are two concerns in the research related to this topic. On the one hand, researchers in supply chain management investigate SI and NPD while researchers in marketing and business look into CI and NPD. Nearly all previous research either investigates SI or CI in NPD process, but ignores the simultaneous impact of SI and CI. There is only one reference (Chien and Chen, 2010) covering both SI and CI about NPD in financial industry. No such reference on manufacturing industry has been ever found. Suppliers and customers are up and down streams of the same supply and value chain. If any of the both is ignored, the whole process of NPD and operations is not complete.

On the other hand, although a great number of authors (e.g. Frohlich and Westbrook 2001, Rosenzweig *et al.*, 2003, Vachon and Klassen 2006, Swink *et al.*, 2007) revealed the positive relationship between SCI and organisational performance, the impact of SCI on performance is far from a fact. Zailani and Rajagopal (2005) propose that little is known about the connections between supplier and customer integration and improved operations performance. Power (2005) concludes the apparent contradiction between promised benefits and limited evidence of extensive implementation. So as to the impact of SI on NPP, the findings are paradoxical. Conceptual claims are mostly positive, but empirical findings are mixed (De Meyer and Van Hooland 1990, Hartley *et al.*, 1997a). In fact, Ittner and Larcker (1997) found that supplier involvement actually hampered NPD project performance by lengthening product development lead times. Thus, Fabbe-Costes and Jahre (2008) in their review caveat that evidence cannot be taken for granted

and call for more research on the impact of SCI on performance.

In summary, the following questions about supply chain integration and its influence on performance are remaining unanswered:

- 1) To what extent will SI and CI influence NPP?
- 2) What dimensions of NPP will be influenced by SI and CI?
- 3) To what extent did companies implement SI and CI?

This paper aims to answer the above questions by an empirical research that investigates the impact of both SI and CI on three dimensions of NPP. Structural equation modeling will be used to test the simultaneous impact of SI and CI on NPP. The result will fill in the gap in NPD and SCM research on the simultaneous impact of supplier and customer involvement in NPD in manufacturing industry.

Literature Review and Hypothesis Formulation

New Product Performance (NPP)

In previous studies, three key indicators were accepted to measure the performance of new product development. They are quality (Hsu *et al.*, 2009; Petersen *et al.*, 2005; Dostaler, 2010) and reliability (Petersen *et al.*, 2005; Corallo *et al.*, 2009; Dostaler, 2010), time to market (Stalk and Hout, 1990; Griffin, 1993; Bonaccorsi and Lipparini, 1994; Langerak *et al.*, 2004; Talke, 2007) and product innovativeness (Montoya-Weiss and Calantone, 1994; Sandvik and Sandvik, 2003; Talke, 2007; Lee, 2008; Molina-Castillo & Munuera-Alemán, 2009a; 2009b). In this study, those three indicators were used to measure the NPP.

New product development (NPD) is about to become a focal point of competition, leading to higher product quality (Bonaccorsi and Lipparini, 1994). Therefore, quality has been considered as a key indicator of new product performance (Dostaler, 2010). Evidences show that successful integration of partners can improve the quality of new product design (Petersen *et al.*, 2005; Dostaler, 2010). Besides, reliability is another key indicator of new product performance as the internal failure rate is considered as a particularly appropriate measure of the performance of the development process (Dostaler, 2010).

All products, especially superior/complex one, should meet reliability standards relative to specifications (García *et al.*, 2008; Corallo *et al.*, 2009). Involvement of supplier can improve the reliability of new product design (Petersen *et al.*, 2005).

As global competitive pressure increases, product life cycles reduce and many manufacturing companies try to shorten their product development cycles (Griffin, 1993; Bonaccorsi and Lipparini, 1994) and move new technology and products from product concept to marketplace in a faster pace (Bonaccorsi and Lipparini, 1994). Therefore, time to market has been identified as a key success factor in NPD (Stalk and Hout, 1990). According to Bonaccorsi and Lipparini (1994), time to market can be reduced by concurrent engineering, earlier identification of technical problems, reduced suppliers' process engineering time, and acquisition of suppliers' production capacity.

New product innovativeness is generally considered as an important indicator of new product performance (Molina-Castillo & Munuera-Alemán, 2009a; 2009b). A firm's ability to employ new and successful product innovations is an important competitive weapon (Sandvik and Sandvik, 2003). Various definitions of product innovativeness in product development have been used in previous studies. Firstly, product innovativeness refers to the firm's use of products that are new to the firm and/or new to the market (Booz, Allen & Hamilton, 1982; Cooper & Edgett, 1999; Danneels & Kleinschmidt, 2001; Kleinschmidt & Cooper, 1991; Olson *et al.*, 1995). New-to-the-firm products are those used by the firm for the first time and they are often imitations of competitors' successful product which are already offered in the market (Cooper, 1994). New-to-the-market products are those that are the first of their kind in the market and they are developed by the firm itself or adopted from firms in other markets and industries (Sandvik and Sandvik, 2003). Secondly, product innovativeness can be defined as the product advantage which customer-perceived superiority as to quality, benefit, and functionality and product uniqueness/superiority (Montoya-Weiss and Calantone, 1994). Thirdly, product innovativeness refers to a product's technical newness or the changes it implies for the innovating firm or for the market it enters (Talke *et al.*, 2009). Fourthly, product innovativeness can be referred to newness to the customer (Garcia and Calantone, 2002). The innovativeness of the product can also lead to the

formation of new business unit(s), the extension of other product lines or the introduction of improvements into other product lines (Lee, 2008), intensification of risk-averse posture towards technology on new product performance (Talke, 2007).

Suppliers Involvement (SI) and NPP

Various definitions of supplier involvement in product development have been used in past studies. Handfield *et al.* (1999) view it as the information suppliers provide and their participation in decision making. Afterwards, Wynstra *et al.* (2003) define it as involvement of decisions and activities related to prioritising, mobilising, coordinating, timing, and informing with regards to these resources, tasks, and responsibilities. Recently, van Echtelt *et al.* (2008) refer it as the resources (i.e., capabilities, investments, information, knowledge, ideas) that suppliers provide, the tasks they carry out and the responsibilities they assume regarding the development of a part, process or service for the benefit of a buyer's current or future product development projects.

Suppliers usually have greater expertise and knowledge regarding the specifications, parts and components which may be essential to a firm's new product development. As a result, supplier collaboration can help firms incorporate the expertise and different perspective of a supplier to improve its solutions or create new methods for product development (Bonaccorsi and Lipparini, 1994; Eisenhardt and Tabrizi, 1995). Supplier involvement also allows firms to identify potential technical problems and speed up new product development (Kessler and Chakrabarti, 1996). O'Neal (1993) revealed that two most significant features of concurrent engineering (i.e. customer focus centering on doing the right things and cycle time reduction focusing on doing them right the first time) can enhance quality and improve time to market of new product development. Hartley *et al.* (1997) analysed product development engineers and managers in 79 assembly industry firms that early supplier involvement can reduce the overall time required to develop new products. Handfield *et al.* (1999) studied 134 companies from 18 countries and revealed that early involvement of suppliers can improve the time to market, quality and technology innovation of new products. Balasubramanian and Baumgardner (2004) studied Unisys that early supplier involvement can improve time- to market of new product. Miotti and Sachwald

(2003) used the French CIS-2 survey to reveal the positive effect of collaboration with suppliers on the share of innovative product turnover. Faems et al. (2005) studied Belgian manufacturing firms and found that suppliers had a positive impact on the proportion of turnover attributed to improved products. Hoegl and Wagner (2005) studied 28 product development projects and found that supplier collaboration positively relates to product quality, and adherence to development schedules. Mikkola and Skjøtt-Larsen (2006) studied a leading Danish hearing aid manufacturer and found that early involvement of suppliers in new product development reduces time-to-market. Nieto and Santamaría (2007) analysed Spanish manufacturing firms and found that collaboration with suppliers had positive impact on the degree of product innovativeness. Knudsen (2007) studied 2000 firms in seven European countries and found that supplier involvement had positive impact on new product innovative performance. Langerak and Hultink (2005; 2008) analysed 233 manufacturing firms and found that supplier involvement can improve the speed of new product development. Rauniar et al (2008) studied a sample of 191 projects from the automotive industry in the United States and found that supplier involvement can reduce product design glitches, thereby reducing development time of the new product. Chien and Chen (2010) studied financial services firms in Taiwan and found that supplier involvement had significant effect on NPD success. Annique Un et al. (2010) stated that R&D collaboration with suppliers was positively related to product innovation. Based on the above evidence, we propose that:

Hypothesis 1a: Suppliers collaboration in NPD process (SC) has a positive impact on new product quality and reliability.

Hypothesis 1b: Suppliers collaboration in NPD process (SC) has a positive impact on time to market.

Hypothesis 1c: Suppliers collaboration in NPD process (SC) has a positive impact on new product innovativeness.

Customers Involvement (CI) and NPP

Customer innovation has become an essential strategy for organisational survival because innovations can come from how organisations interact with customers by (1) receiving the insights, ideas, thoughts, and information from customers, (2) encouraging customers to engage in improving existing products and services, and (3)

collecting, developing and commercialising customers' ideas rapidly (Desouza et al., 2008). Involvement of customers is important in the early stage of NPD process and it has a positive effect on customer satisfaction which can lead to better firm performance (Tan and Tracey, 2007) and new product success (Gruner and Homburg, 2000). In the late stages of new product development process, customer involvement can also increase new product success. However, in the medium stages of new product process, interaction with customers cannot yield any performance impact (Gruner and Homburg, 2000). Customer involvement in NPD can also speed up the process of adoption necessary for success (Johnson and Filippini, 2009).

Collaborating with customers (CC) is an important way for a firm to improve its product innovation performance (Gupta et al., 2000; Fritsch and Lukas, 2001; Brockhoff, 2003; Tsai, 2009). CC is significant in the early stage of the NPD process and working with customers can eliminate the likelihood of poor design in this stage of development (von Hippel et al., 1999). Besides, understanding the needs of customers may help firms gain new ideas about solutions (von Hippel et al., 1999), thereby increasing the chances of new product development and success. Thus, CC may lead to product innovation advantages (Souder et al., 1997; Li and Calantone, 1998) and it has a positive impact on product innovation performance (Miotti and Sachwald, 2003; Freel, 2003; Faems et al., 2005). Cooper and Slagmulder (2004) stated that customer involvement can improve the quality and reliability of the new product developed. Singh et al (2007) used a questionnaire-based survey and interpretive structural modelling (ISM) approach in their study and found that customer involvement can improve product quality and reduce development time. Rauniar et al (2008) studied a sample of 191 projects from the automotive industry in the United States and found that customer involvement can reduce product design glitches, thereby reducing development time of the new product. Chien and Chen (2010) studied financial services firms in Taiwan and found that customer involvement had significant effect on NPD success.

However, customer involvement has no influence or negative influence on the new product performance under certain circumstances. Asking customers for solutions tends to undermine the innovation process because most customers have a very limited frame of reference.

Customers only know what they have experienced and they cannot imagine what they don't know about emergent technologies, new materials, and the like (Ulwick, 2002). In addition, Annique Un et al. (2010) state that R&D collaborations with customers do not appear to affect product innovation. Bonner (2010) also states that customer interactivity is positively related to customer information quality when developing highly innovative products, but not when developing modifications or extensions of existing products. Fang (2008) indicates that customer participation has a negative influence on innovativeness when downstream customer network connectivity is high but a positive effect when it is low. In contrast, customer participation has a positive effect on speed to market when downstream customer network connectivity is high and no significant effect when it is low.

Feiereisen et al. (2008) state that 40% to 90% of new products fail due to consumers' lack of understanding of product features and benefits.

Based on the above evidence, we propose that:

Hypothesis 2a: Customer collaboration in NPD process (CC) has a positive impact on new product quality and reliability.

Hypothesis 2b: Customer collaboration in NPD process (CC) has a positive impact on time to market.

Hypothesis 2c: Customer collaboration in NPD process (CC) has a positive impact on new product innovativeness.

A conceptual model covering the six hypotheses is proposed as shown in figure 1.

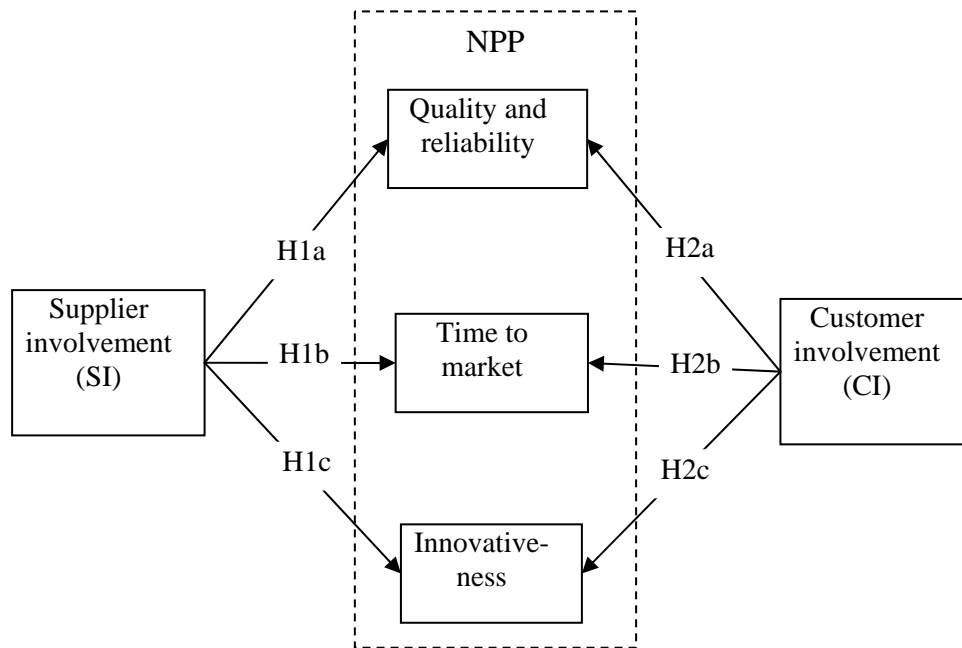


Figure 1. The conceptual model showing the six hypotheses among SI, CI and NPP

Empirical Data

The research firstly proposed seven hypotheses relating among supplier integration and collaboration, customer integration and collaboration, new product development activities and performance. It then tested the hypotheses based on the data from the fourth round of International Manufacturing Strategy Survey (IMSS) in 2005. IMSS is an international research network consisting of more than 20 countries and over 600 companies around the world. The

project aims to investigate manufacturing priorities, practices and performance of world manufacturing companies. The participant companies are in the metal products, machinery and equipment industry, i.e. ISIC 38 segment.

The research reported in this paper is based on the data from the fourth round of IMSS survey in 2005. Phone contact was first conducted in most of the participating countries to affirm the respondent companies. The

questionnaires were forwarded to Director of manufacturing or operations or equivalent persons in respondent companies via mailing, fax or on-site interview. In countries where English is not prevailing, the questionnaire was translated into local native languages by operations management researchers. Participating countries sent their data to the coordinator who forwarded the final database to all participants. For this study, sample firms are from 21 countries. The total sample size is 660. The sample profiles for 21 participating countries are presented in Table 1.

The IMSS questionnaire was developed by a team of experts in manufacturing strategy. It covers manufacturing strategy, practices, performance as well as market situation. Supply chain integration, customer integration and new product performance are also covered. Among other, SI, CI and NPP performance are all measure by 1-5 scales. They measure the changes of SI and CI in the past three years. The questions are listed in Table 2.

Countries	Frequency	Percent	Cumulative Percent
Argentina	44	6.7	6.7
Australia	14	2.1	8.8
Belgium	32	4.8	13.6
Brazil	16	2.4	16.1
Canada	25	3.8	19.8
China	38	5.8	25.6
Denmark	36	5.5	31.1
Germany	18	2.7	33.8
Greece	13	2.0	35.8
Hungary	54	8.2	43.9
Ireland	15	2.3	46.2
Israel	20	3.0	49.2
Italy	45	6.8	56.1
New Zealand	30	4.5	60.6
Norway	17	2.6	63.2
Portugal	10	1.5	64.7
Sweden	82	12.4	77.1
Netherlands	63	9.5	86.7
Turkey	35	5.3	92.0
UK	17	2.6	94.5
USA	36	5.5	100.0
Total	660	100.0	

Table 1. Sample profiles by Countries

Questions	Measurement				
Improvement of NPP in the past three years:	None	Some	Great		
-New Product quality and reliability	1	2	3	4	5
-Time to market	1	2	3	4	5
-Product innovativeness	1	2	3	4	5
Implementation of suppliers and customers involvement in NPD in past three years:	None	Some	Great		
-Supplier involvement	1	2	3	4	5
-Customer involvement	1	2	3	4	5

Table 2. Questions about SI, CI and NPP

Results

The basic statistics of the five variables are summarised in table 3. It can show that in the past three years, companies made improvement in three of the dimensions of NPP.

Also companies implemented SI and CI as well. However, a t-test shows that there is significant difference between the means of SI and CI ($t=10.23, p<0.001$). It implies that companies pay more attention to CI (mean=3.47) than SI (mean=2.92).

	N	Min	Max	Mean	Std. Deviation
Quality and reliability	692	1	5	3.07	.851
Time to market	679	1	5	2.83	.888
Product innovativeness	682	1	5	2.89	.885
Supplier involvement	683	1	5	2.92	1.106
Customer involvement	682	1	5	3.47	1.096

Table 3. Basic statistics of NPP, SI and CI

New product performance (NPP)	Supplier involvement	Customer involvement
-New Product quality and reliability	0.17**	0.13**
-Time to market	0.16**	
-Product innovativeness	0.14**	0.10*

Notes: $p^* < 0.05, p^{**} < 0.001$ (all one-tailed tests)

Table 4. Simple correlation analysis

Simple correlation is conducted first as shown in table 4. Except for the relationship between CI and time to market, all other relationships are significant. However, Structural Equation Modeling (SEM) produces different result for the impact of CI. The testing results are shown in figure 2. The fitness indexes are $CMIN/DF=1.754<3$, $NFI=0.988$, $RFI=0.914$, $IFI=0.995$, $TLI=0.961$, $CFI=0.995$, $RMSEA=0.033$. The model shows that H1a, H1b, H1c,

and H2a are supported but H2 and H2c are not supported. It is also observed that the correlation between SI and NPP is stronger (0.14 to 0.16 vs 0.08) and more significant ($p<0.001$ vs. $P<0.01$) than those between CI and NPP. The implications of the results will be discussed below.

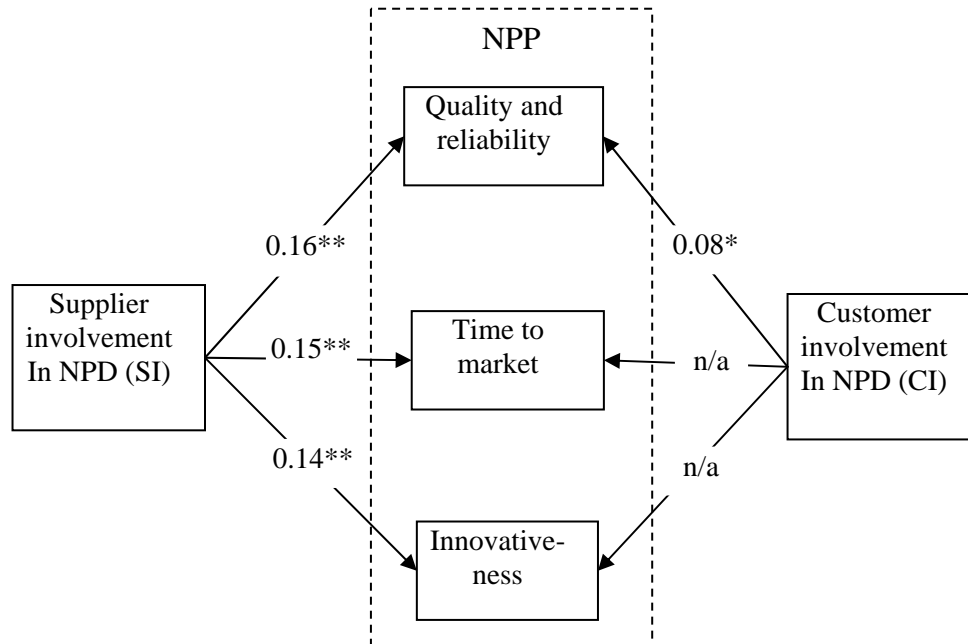


Figure 2. The result of hypotheses testing (**: $p < 0.001$; *: $p < 0.05$)

Discussions

The research reveals that there are differences in the impact of SI and CI on NPP. Consistent with previous research, this research supports the hypotheses that SI positively influences NPP. SI positively influences all the three dimensions of NPP, including new product quality and reliability, product innovativeness and the time to market. However, contradict to previous research, CI influences only on the quality and reliability. Hypotheses on the impact of CI on time to market and innovativeness are not supported. The different result may be explained from methodological perspective as well as customer expectations.

First, different data analysis method may lead to different results. Previous research on the relationship between CI and NPP covered only SI and was based on simple correlation. Simple correlation method treats all variables as independent and, as a result, ignores the simultaneous impact of SI and CI. SEM covers all the variables and the potential relationships among the variables. This suggests that if the variables may have interrelation among each other, a conceptual model should be proved and tested by Structural Equation Modeling (SEM).

Second, the customer, especially end users of new product, may not have sufficient technical knowledge to help manufacturers improve the production process in order to shorten the time to market and develop innovative products. This finding is also supported by Ulwick (2002), Fang (2008) and Annique Un et al. (2010). Conversely, customers only concern the quality and reliability products. For industrial users, a company may not want their customer to know too much of their technical details for confidential reasons. This implies that future research should separate customers into different types such as end users and industrial users. Customer involvement may drag the NPD process longer since they always ask too much from the company.

This research has a few implications for research design. First, SI and CI are both studied in this research. Previous research mostly looks at either SI or CI. However, SI and CI affect NPP simultaneously and therefore; both should be considered in such research. Collaboration theory suggests that companies need to collaborate with suppliers in SCM field or customer from marketing perspective. Both streams of research hold a two-party perspective about collaboration in NPD. This research finds that both SI and CI are important and suggests a three-party perspective, including the company, the suppliers and the customers. This suggests the shift from a two-party

perspective to a three-party perspective in NPD. The three-party perspective implies that a new mechanism is needed to coordinate both the suppliers and the customers at the same time.

Another implication is that NPP is not a single dimension variable. NPP covers at least three dimensions like quality, reliability, innovativeness and time to market. The separation of the three dimensions help people get into the insight of impact of SI and CI. It is not enough to find out whether SI and CI influence on performance. It is more meaningful to find out what SI and CI influence. This research suggests a multidimensionality of new product performance.

There are also a few practical implications for managers. The research suggests that both SI and CI should be implemented in new product development process. Although more research has been conducted on SI recently, it seems that more efforts in both academic and practical fields are needed to enhance SI in NPD. There are several practical issues to explore for managers and researchers. For example, shall a company start with SI first or CI first? Is there any interrelationship between SI and CI? Will supplier and customer work together? If so, who will coordinate with SI and CI which are in different functional departments? Will electronic system influence the SI and CI? If so, how to implement ERP (Enterprise Resources Planning) to enhance SI and CI?

There are also other implications for future research. Factor influencing SI and CI have attracted attention of researchers. It will continue to be an interesting and attractive to investigate factors enhancing SI and CI. For example, commitment and trust are often cited in the field. However, are there any differences between the factors which influence SI and CI? If there are differences, how can a company play the different roles along the supply chain to enhance SI and CI? Another stream of research related to SI and CI is the conditions or factors that mediate SI and CI. For example, research reveals that market stability will mediate SI (Jayalarn, 2008). Future research can be conducted to explore the conditions for both SI and CI.

Conclusion

This paper investigates the simultaneous impact of SI and CI on NPP. There are two new points in this research. The first is the research design from a two-party

perspective to a three-party perspective. The three-party perspectives will have an impact on the research on SI, CI and NPP in the future. Another contribution is the elaboration of NPP from one construct of NPP to three dimensions. The three-party perspective and multi-dimension of NPP will greatly enrich the research on NPD in the future.

The limitation of this research lies in the measure. All variables are measured by simple 1-5 scales. Future research can use well designed constructs with more items. Additionally, comparative studies can be conducted to probe into the difference in SI and CI impact on new product performance in different countries or industries.

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