# THE INVOLVEMENT OF SUPPLY CHAIN PARTNERS IN NEW PRODUCT DEVELOPMENT: THE ROLE OF A THIRD PARTY

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## ABSTRACT

This paper examines the effect of supply chain and third party involvement on product innovation performance. The concept of supply chain network is studied as the type of external member collaboration for firm new product development. This study collected information about 208 manufacture firms from Taiwan; we investigated the contingent effect of supply chain member involvement on product innovation performance. The result indicate that external member involvement have positive impacts on a product innovation performance, and third party involvement within the supplier involvement is found to be as important a moderator for the relationship between external member involvement and product innovation performance. The relationship between customer involvement and market performance was positively moderated, but between supplier involvement and design performance was negatively moderated by third party involvement.

***Keywords***: Supply Chain Management, New Product Development, Third Party Involvement, Product Innovation Performance

## 1. INTRODUCTION

One of prevailing findings in concurrent inter-firm network and supply chain management research is that customer and suppliers can reap great potential benefits by working together the new product development (NPD) process. Over the past two decades, several researchers have shown that new product development has become an increasingly important to the development and maintenance of a strong position in an increasingly competitive business arena [15, 56]. Consequently, the demands on new product development performance, in terms of speed, performance, quality, and cost, have become more stringent. Today's leading enterprises operate on a global basis, cooperating with suppliers, partners, and a multitude of stakeholders to deliver product packages [45]. Therefore, new product development must come from within the supply chain or network.

Companies experience constant pressure to deliver superior value to the customers. In addition to resource inputs, this requires a set of processes to coordinate efforts and improve results. Increasingly, many of these capabilities and resources reside outside the boundaries a single firm. Earlier and more extensive involvement of suppliers and customer in new product development is one of the ways companies can enhance product development in terms of productivity, speed, quality [14, 50] market share, sales volume, and market growth. Suppliers provide a source of innovative ideas and critical technologies [5, 12]. Customers provide demand and market knowledge [35, 40, 65, 66]. However, several studies demonstrate that managing supplier involvement in product development poses several challenges [11, 30]. On the other hand, other scholars believe that the network and the relationships in themselves have an impact on how industrial firms gain and deal with

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new knowledge. At the same time, relationships and networks are not homogeneous, but tend to differ in the configurations [6, 13]. Recently, a number of scholars have challenged the conventional notion that innovations in the supply chain context originate from the buyer alone. In the current complex technological era, innovation generation is a multidisciplinary activity spanning a multiplicity of organizations, circumstances, and settings [28, 33, 43, 63, 68].

Based on this concept, this study shows that innovation results from interactions within buy-seller relationships [18, 55]. Scholars agree that a substantial part of the innovation process occurs between buyers and sellers in the supply chain [28, 36]. This has led to the emergence of a large body of strategy-level research on inter-firm network interaction and technical development. With the advent of manufacturing in the business process and enterprise resource-planning systems that are externally linked to the customer through a customer relationship management system, suppliers have become integrated with supply chain management. Academics and practitioners show interest in improving innovation performance for long-term gains by analyzing supply chain management systems.

Upstream and downstream sections of the supply chain involve manufacturing activities that occur before a new product moves to distribution channels. Extant research on innovation in supply chain relationships focus on the auto industry [14], and tend to emphasize operations and total quality management rather than marketing. However, companies do not develop new products simply to improve quality or reduce costs. There are market and financial performance incentives as well. Therefore, this study further clarifies the supply chain members involved in the new product development process. Specifically, design and market performance help distinguish the contributions of three types of members. This study argues that buyer-seller interactions in the supply chain affect upstream and downstream innovation. Product innovation performance refers to the extent to that product innovation reaches its target [51]. In the past, most evaluations of product innovation performance considered design performance and market performance [16]. In recent years, research evaluation indicators have included financial performance [46]. A comparison of these approaches shows that financial performance and market performance evaluation indicators are very similar. To distinguish them from general operational performance financial indicators, this study uses design performance and market performance to evaluate product innovation. From an academic perspective, this framework facilitates a better understanding of the innovation process (Figure 1).

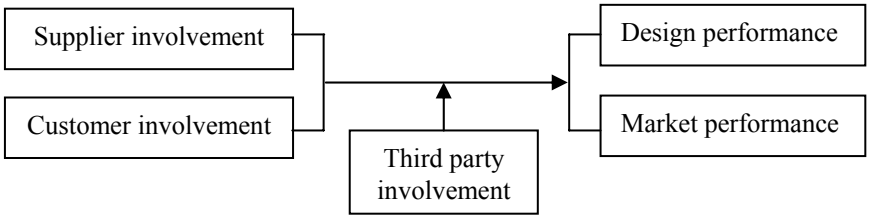


Figure 1: Research framework

# 2. INTER-ORGANIZATION COLLABORATION FOR PRODUCT INNOVATION WITHIN THE SUPPLY CHAIN

Marketing literature shows that inter-organization collaboration influences product innovation performance. This inter-organization collaboration refers to two or more organizations jointly creating or using existing tactics or rules, and cooperating to deal with the various types of work and challenges in an environment [2]. Firms can engage in collaboration arrangements for product innovation with several types of partners. These partners include competitors, universities, consultants, research institutes, research and technology organizations, and other associations. However, inter-organization collaboration with competitors can cause great suspicion due to the potential for competitive behavior. Therefore, this study suggests that competitors are less likely to participate in new product development. Finally, this study explores the effects of inter-organization collaboration between suppliers, customers, and third parties on performance.

### 2.1 Effects of Customer Involvement

The importance of lead customers in defining product innovation, and therefore reducing the risk associated with the market introduction, has been recognized since at least the 1970s [24, 49, 52, 53, 59, 61, 62]. A review of previous studies reveals the following advantages of customer involvement:

providing complementary knowledge, providing an understanding of customer demand; auxiliary pricing, etc. Gemunden, Heydebreck, and Herden [25] showed that customer contact is a prerequisite for success, and that allowing customers to participate in the early stages of new product development is important [38]. Research by Sherman, Souder, and Jenssen (2000) [54] shows that including the customer in the R&D team reduces the development time of new products. However, these findings are the result of a company's one-way requirements; customers only provide information, and the participation is therefore relatively low. According to Gadde and Snehota's [23] classification of high involvement, a high level of customer involvement must include relation-specific investment and a high level of interaction. The most obvious effect of customer participation in new product development is better time performance in market and technical development [14, 54]; these are important market performance indicators. Previous studies show that customer participation primarily affects market performance, and to a lesser extent, assists in technical aspects such as design performance. Therefore, this study infers the following hypothesis:

H1: The greater the customer involvement, the greater the new product's (a) design performance and (b) market performance.

**2.2 Effects of Supplier Involvement**

Research on new product development shows that three of these firm-centered factors include design for cost, design for quality, and design for manufacturability are important for the creation of product innovation performance [14]. Looking beyond the individual firm is necessary to recognize the importance of technology knowledge in the supply chain [58]. Although many studies focus on integrating customer requirements into new product development efforts [26], supplier involvement has only recently received significant attention [46]. Along with the need to integrate multiple linked processes in the supply chain, theoretical research advocates that early and extensive supplier involvement results in a faster development process [46, 21, 29].

One way that a company can boost its competitive advantage is to allow supplier involvement in design and product development. A company that uses supplier expertise to enhance its in-house capability can reduce the time it takes for a product to go from conception to the market place, improving cost and quality, and achieving better design performance [50]. Petersen et al. [46] used the inclusion of suppliers in new product development teams to verify that supplier involvement enhances project efficiency, and thus influences financial performance and design performance. Song and Benedetto [57] found that good suppliers facilitate the growth of a product's market share and improve financial performance. Supplier involvement boosts the design and market performance of manufacturers. Therefore, this study hypothesizes the following:

H2: The greater the involvement of suppliers, the greater the new product's (a) design performance, and (b) market performance.

**2.3 Moderating Effects of Third Party Involvement**

Universities and government research institutes are important contributors to the creation of scientific and technological knowledge [37, 41]. This is particularly true in Taiwanese universities and government research institutes that have been under considerable pressure to move closer to industry. The Taiwanese government has sought to encourage these institutions to undertake more industrially relevant research to assist the competitiveness of Taiwanese industry.

In the past, many believed that inter-organization collaboration improved innovation performance. However, some research shows the opposite to be the case. Wynstra, et al. [69] found that early supplier involvement does not lower costs or improve quality, and can even result in worse than expected results. Belderbos, et al. [10] showed that the involvement of third parties, such as universities or research institutions, could improve productivity and result in greater sales performance in the innovative product market. Universities are therefore an important resource for companies seeking innovation knowledge. Lynch and O'Toole [38] conducted a survey of Ireland's manufacturing industry and found that as much as 57% of respondents involved third parties in the new product development. The main reasons for this involvement included responding to customer requirements, acquiring expertise, creating market opportunities, and lowering costs, risks, and development time. Therefore, this study believes that third party involvement in companies' R&D can improve market performance acquire technical expertise for the company. Therefore, this study hypothesizes the following:

H3: Supplier involvement creates a stronger, positive relationship with (a) design, and (b) market performance when the involvement of third party research institutions or universities is high.

H4: Customer involvement creates a stronger, positive relationship with (a) design, and (b) market performance when the involvement of third party research institutions or universities is high.

# 3. METHODS

### 3.1 Sample

The primary sample of this study consisted of R&D managers and executives of Taiwanese manufacturers. This study examines four major types of manufacturing: livelihood industries (including SIC08, 09, 10, 11, 13, 14, 22, 31), the chemical industry (including the SIC12, 15, 16, 17, 18, 19, 20, 21), information and electronic industry (including the SIC 26, 27, 28, 30), and metal machinery industry (including the SIC 23, 24, 25, 29). These industries were targeted to produce a large enough sample for subsequent industry analysis. These specific SICs were chosen because they are some of the most visible and important manufacturing industries. A questionnaire was used for data collection. This study received 245 surveys, but 37 of them were unusable as several parts were missing or the responses appeared to be repetitive, rendering them unacceptable for data analysis. This led to 208 useable responses. Table 1 describes the sample statistics that indicate that 85.8% of the responses came from the targeted SIC codes. The majority of respondents were new product development professionals from firms with less than 200 employees.

Table 1: Sample description (N=208)

| Industry name and SIC code | percent | Number |
|---|---|---|
| Respondents by SIC code | | |
| The people's livelihood industries; 08,09,10,11,13,14,22,31 | 15.8 | 33 |
| The chemical industry;12, 15,16,17,18,19,20,21 | 7.6 | 16 |
| Information and electronic industry; 26, 27,28,30 | 15.8 | 33 |
| Metal machinery industry; 26, 27,28,30 | 46.6 | 97 |
| Total | 85.8 | 179 |
| Number of employees (Firm by size) | percent | Number |
| 0-50 | 44.2 | 92 |
| 51-199 | 24.5 | 51 |
| 200-499 | 14.9 | 31 |
| 500-999 | 5.8 | 12 |
| 1000-1999 | 2.9 | 6 |
| 2000~ | 7.7 | 16 |

### 3.2 Measures

The measurement items for each construct were taken from relevant literature and adjusted for the conditions and characteristics of Taiwanese manufacturing industry. All the items adapted from English were translated into Chinese and then back translated into English to validate translation equivalence [19]. The original and back-translated version were compared for conceptual equivalence and refined where necessary. Five executive MBA students were invited to participate in the pre-test phase after the first draft was complete; further modifications to the applicability, clarity, comprehensibility, and logic of the overall design were made based on the assessment. All items, except demographic items, were measured on a Likert 7-point scale. The Appendix lists the measurement items.

Product innovation performance is a multidimensional construct [46, 57, 27]. This study divided product innovation performance into design performance and market performance. Each performance was separately measured on a four-item scale adapted from Petersen et al. [46] and Langerak and Robben [32].

Supplier involvement was measured on a four-item scale adapted from Lim et al. [34]; Walter [64] and Song and Benedetto [57]. The items included (1) suppliers involved in early stages of product development; (2) supplier input for parts design; (3) supplier input for prototype test; and (4) product development people meeting suppliers. Supplier input for parts design showed a low factor loading, and then deleted.

Customer involvement was measured on a five-item scale adapted from Lim et al. [34]. The items included involvement in the early stages of product development, using customers as a source for ideas, listening to customers' needs, using information from customers, and meetings between product development people and customers. The last item showed a low factor loading, and then deleted.

Third party involvement was measured by five items developed specifically for this study. These items captured supplier and customer involvement in the early, prototype test, co-design, information sharing, and meeting stages.

Control variables. The literature suggests that several industrial variables may affect product innovation performance. This study included several variables commonly used as control variables in management and marketing research studies, including firm size, market turbulence, and technological turbulence. The market turbulence and technological turbulence scales were adapted from Jaworski and Kohli [31].

**3.3 Reliability and Validity**

This study used LISREL 8.72 to analyze the research model. The ability of each multi-item scale to capture its construct was first assessed using the measurement model of all constructs. Internal consistency reliability, convergent validity, and discriminant validity were all checked before testing the hypotheses [4]. First, based on confirmatory factor analysis (CFA), we deleted items and compressed dimensions. All the fit indices revealed an acceptable fit. ($\chi 2$ (231) = 459.31, p = 0.0); root mean square error of approximation [RMSEA] = 0.069; normed fit index, [NFI] = 0.92; comparative fit index [CFI] =0.96; goodness-of-fit index [GFI] = 0.84; adjusted goodness- of-fit index [AGFI] = 0.80).

Secondly, in the aspect of reliability, Cronbach's α of each variable was between 0.76 and 0.90that was above 0.70 recommended by Nunnally & Berstein [44]. The composite reliability (CR) of measurable variable was between 0.77 and 0.90that was above 0.6 recommended by Bagozzi and Yi [7] and Fornell and Larcker [22], revealing that the research variables were in the acceptable range.

Finally, we measured validity using the convergent validity and discriminant validity approach proposed by Anderson and Gerbing [4]. The factor loading t value was between 7.85 and 15.18, and each of the measurable variables was significant that was consistent with Anderson and Gerbing [4]. The average variance extracted (AVE) of the measurable variable was between 0.46 and 0.69, except that customer involvement was lower than the 0.5 level recommended by Forrnel and Larcker [22]; the others variable were all accepted. These results show that the proposed measurement model achieved a good convergent validity. Discriminant validity is obtained when all pair wise latent-trait correlations of constructs are significantly different from 1 [4]. Table 3 shows that our construct measures met this requirement. A more stringent criterion of discriminate validity is that across all possible pairs of constructs the variance extracted for each construct must be greater than the squared latent correlation between a pair of constructs [22]. Table 2 shows that the diagonal elements representing the squared roots of average variance extracted values for each of the constructs were greater than the off-diagonal elements, thereby achieving discriminant validity.

Table 2: presents the correlation matrix and descriptive statistics for the measures

| | Mean | S.D. | SI | CI | TI | DP | MP | TC | MC |
|---|---|---|---|---|---|---|---|---|---|
| Supplier involvement | 5.06 | 1.24 | **0.52** | | | | | | |
| Customer involvement | 5.44 | 1.09 | 0.286** | **0.46** | | | | | |
| Third party involvement | 4.77 | 1.32 | 0.308** | 0.259** | **0.69** | | | | |
| Design performance | 5.44 | 0.99 | 0.387** | 0.405** | 0.518** | **0.66** | | | |
| Market performance | 5.05 | 1.10 | 0.263** | 0.363** | 0.349** | 0.622** | **0.68** | | |
| Technology uncertain | 5.21 | 1.20 | 0.309** | 0.196** | 0.336** | 0.384** | 0.402** | **0.66** | |
| Market uncertain | 4.68 | 1.30 | 0.07 | -0.04 | 0.322** | 0.273** | 0.288** | 0.461** | **0.65** |

[a] n=208. Correlations greater than 0.20 are significant at $p < 0.01$. AVE coefficients are on the diagonal in parentheses.

Table 3: The reliability and validity analysis of each measurable variable (Continued)

| Index | Mean | Standard deviation | Factor loading | *t* | CR | AVE | Cronbach *α* |
|---|---|---|---|---|---|---|---|
| Supplier involvement 1 | 5.27 | 1.59 | 0.69 | 10.36 | 0.81 | 0.52 | 0.81 |
| Supplier involvement 2 | 4.64 | 1.62 | 0.74 | 11.35 | | | |
| Supplier involvement 3 | 4.74 | 1.62 | 0.74 | 11.23 | | | |
| Supplier involvement4 | 5.58 | 1.36 | 0.72 | 11.00 | | | |
| Customer involvement 1 | 5.19 | 1.71 | 0.77 | 11.63 | 0.77 | 0.46 | 0.76 |
| Customer involvement 2 | 5.67 | 1.26 | 0.64 | 9.23 | | | |
| Customer involvement 3 | 5.76 | 1.15 | 0.56 | 7.85 | | | |
| Customer involvement 4 | 5.13 | 1.50 | 0.72 | 10.56 | | | |
| Third party involvement 1 | 5.00 | 1.50 | 0.80 | 13.32 | 0.90 | 0.69 | 0.90 |
| Third party involvement 2 | 4.88 | 1.49 | 0.86 | 14.97 | | | |
| Third party involvement 3 | 4.57 | 1.50 | 0.83 | 14.27 | | | |
| Third party involvement 4 | 4.64 | 1.56 | 0.82 | 13.86 | | | |

Table 3: The reliability and validity analysis of each measurable variable (Continued)

| Index | Mean | Standard deviation | Factor loading | *t* | CR | AVE | Cronbach *α* |
|---|---|---|---|---|---|---|---|
| Design performance 1 | 5.55 | 1.05 | 0.80 | 13.20 | 0.85 | 0.66 | 0.85 |
| Design performance 2 | 5.47 | 1.13 | 0.80 | 13.16 | | | |
| Design performance 3 | 5.28 | 1.19 | 0.83 | 13.91 | | | |
| Market performance 1 | 5.25 | 1.10 | 0.79 | 13.12 | 0.87 | 0.68 | 0.86 |
| Market performance 2 | 5.11 | 1.25 | 0.88 | 15.18 | | | |
| Market performance 3 | 4.78 | 1.36 | 0.81 | 13.51 | | | |
| Technical uncertainty 1 | 5.22 | 1.42 | 0.85 | 14.11 | 0.85 | 0.66 | 0.85 |
| Technical uncertainty 2 | 5.48 | 1.25 | 0.81 | 13.23 | | | |
| Technical uncertainty 3 | 4.93 | 1.43 | 0.78 | 12.53 | | | |
| Market uncertainty 1 | 4.38 | 1.52 | 0.83 | 13.72 | 0.85 | 0.65 | 0.84 |
| Market uncertainty 2 | 4.89 | 1.45 | 0.89 | 15.17 | | | |
| Market uncertainty 3 | 4.77 | 1.50 | 0.69 | 10.71 | | | |

Table 4: Results of Moderated Regression Analysis (N=208)

| Variables | Design performance | | | Market performance | | |
|---|---|---|---|---|---|---|
| | model 1 | model 2 | model 3 | model 1 | model 2 | model 3 |
| **Control** | | | | | | |
| Technology uncertain | .328*** | .123* | .141* | .342*** | .212** | .184* |
| Market uncertain | .122$^{+}$ | .109* | .110$^{+}$ | .131$^{+}$ | .150* | .156* |
| **External organization involvement** | | | | | | |
| Supplier involvement | | .169** | .147* | | .066 | .072 |
| Customer involvement | | .229*** | .251*** | | .272*** | .324*** |
| Third party involvement | | .242*** | .323*** | | .139* | .144* |
| Supplier involvement × Third party involvement | | | -.142* | | | -.013 |
| Customer involvement ×Third party involvement | | | .035 | | | .158* |
| Adjust $R^2$ | | .398 | .410 | | .276 | .290 |
| $R^2$ | .159 | .412 | .430 | .175 | .293 | .314 |
| ***F*** | 19.405*** | 28.347*** | 21.532*** | 21.711*** | 16.764*** | 13.072*** |

[1] Standardized regression coefficients are shown
[2] + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

# 4. RESULTS

Following the Baron and Kenny [8] approach, the main and moderating effects were tested using hierarchical multiple regression analyses. To mitigate the potential of multicollinearity, each scale constituting an interaction term was mean centered [1]. Table 4 summarizes the results.

Regarding the hypotheses that external organization involvement enhance product innovation performance, we found that customer involvement was significantly related to market performance (β=.324 , p＜.001). However, customer involvement was significantly related to design performance (β=.251, p ＜ .001). As expected, the supplier involvement was significantly related to design performance (β=.147, p＜.05), supporting Hypothesis 2a. However, supplier involvement was not significantly related to market performance (Hypothesis 2b). This finding revealed a different facet of customer involvement, partially supporting Hypothesis 2a. Moreover, third party involvement was significantly related to design and market performance (β=.323, p＜.001；β=.144, p＜.01). Third party involvement had a moderating effect on the relationship between supplier involvement and design performance (β=.-.142, p ＜ .05), but no moderating effect on market performance. This means that higher levels of third party involvement increase the negative relationship between suppliers and design performance. These results support Hypothesis 3a, but not Hypothesis 3b. To plot this interaction effect, we constrained the variables in

model 3 except supplier involvement and third party involvement to means. Supplier involvement and third party involvement took the values of one standard deviation blow (a low level) and above (a high level) the mean. The plot of this interaction in Figure 2 is consistent with Hypothesis 3a. In contrast, third party involvement might moderate the relationship between customers and market performance ($\beta$=.158, $p < .05$), supporting Hypothesis 4b. The plot of this interaction in Figure 3 is consistent with Hypothesis 4b.

Among the control variables, technology uncertainty had a significantly positive relationship with design performance and market performance. These findings suggest that in the development of new products, enterprises should pay attention to the technical uncertainties of environmental change will have performance. Market uncertainty was positively related to market and design performance. In particular, understanding customer needs and preferences is important.

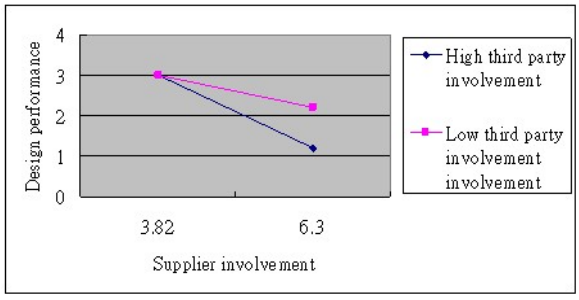


Figure 2: Moderating effect of third party involvement

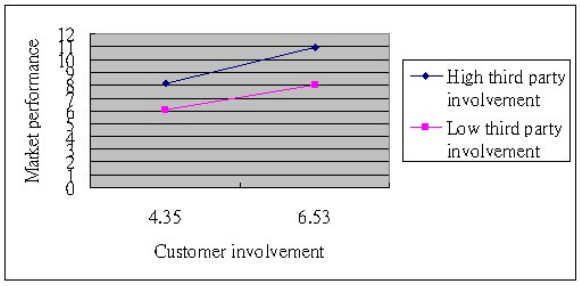


Figure 3: Moderating effect of third party involvement

# 5. DISCUSSION AND SUGGESTIONS

## 5.1 Discussion

Previous studies typically provide limited discussion of the relationship between the involvement of third-party supply chain partners and product innovation performance. Unlike previous studies, the current study explores the affects of supply chain partner involvement to determine the influence that suppliers and customers have on design and market performance. This study examines the moderating effect that third party involvement has on inter-organization collaborative interaction relationships and product innovation performance. This study finds that continuity and diversity of partner collaboration positively affects product innovation performance. This finding agrees with earlier studies showing that collaboration is a good way to improve a firms' product innovation performance [9, 42].

Secondly, the choice of partner in the collaborative network may be a major factor in product innovation performance. Previous studies on cross-organization collaboration analyze the effect that different types of partners may have on product innovation performance [3]. By examining the effects of suppliers, customers, and third parties on product innovation performance, this study shows that greater supplier involvement strengthens design performance. This may be due to the knowledge and technology provided by supplies that have a direct effect on design performance and an indirect effect on market sales performance. Contrary to our original hypothesis, customer involvement simultaneously increases design performance and market performance that. However, the industry customers in this study do not merely provide requirement information like ordinary consumers; industry customers possess similar technical and professional knowledge, and have a substantial effect in providing technical level information during product development. Results show diversity in the make-up of supply chain inter-firm collaborative favors innovation performance. Being integrated in a supply chain network provides access to diverse sources of information and enables firms to transfer and apply that knowledge. When this happens, firms find themselves better adapted to market changes and technology.

Third party involvement affects market performance and design performance. These results agree with previous research [10]. Because third parties are impartial professional entities, such as universities and research organizations, they that can provide manufacturers with advanced technical theory and market knowledge that lead to better design and market performance. This shows that third party cooperation, with no relation to market competition, can improve product innovation performance.

Finally, this study shows that third-party involvement has been on suppliers and customers participate in a regulatory effect of product innovation performance. The integration of different partners will create different affects on innovation performance. Therefore, the selection of a suitable partner is crucial for a firm. The significant differences of partners can determine how the

collaboration is managed and what kind of innovation performance can be achieved. The specific characteristics and objectives of each type of partner suggest that different partners will bring different results. In this sense, the decision to pool resources with another organization depends on weighing the risks against the expected results [47]. Supply chain partner collaboration allows a firm to gain considerable knowledge about new technology, market, and process improvement [67] and has a more significant impact on product innovation [39]. By considering the individual impact of each type of partner, this study shows that supplier involvement are the single partners who most impact on the achievement of product design with more degree of performance. When third party and suppliers involved in new product development process at the same time, its impact is weakened. This finding indicates that some factors remain to be explored. Future research stage to the sequence from the process and the individual has knowledge of the essence.

### 5.2 Implications for Management

The findings of this study contain useful managerial implications. In the current competitive environment, the achievement of product innovation success is becoming increasingly important. This study shows that different types of collaborative relationships can be a critical success factor in achieving innovative products. The practical value of these findings lies in better understanding how the type of a collaborative relationship affects its own performance. Therefore, managers must be aware of the importance of partner suitability, network mechanisms, and continuity of collaboration, as these are the factors that determine superior collaborative performance in product innovation and the development of the firm's competitive advantage.

This study shows that the involvement of different external organizations produces different results. This provides businesses with a practical choice of partners. For example, when companies wish to pursue design performance, they must not overlook the effects of the expertise of industry customers on product innovation performance, in addition to supplier and third party participation. If an organization wants to improve its market performance, its can employ the customer and third party participation model, with customer participation being the most important factor.

The moderation of third party involvement on supply chain member collaboration and innovation performance is more evident with third party involvement. For example, allowing universities and research institutions to better understand the industry and a company's new product development, or increasing trust between parties through industry-academic cooperation, improves a company's product innovation performance.

### 5.3 Limitations and Future Research

This study is not free from limitations. It would be desirable to have complete information on the degree of product innovation, either using a richer category of innovation or qualitative measures of innovation performance. In addition, this study examines third-party participation using only universities and government research institutions. However, the definition of a wider range of third-party organizations could further distinguish the effects of third-party organizations, such as manufacturing and services, technology and market knowledge, etc.

New technology, patent number, or the cause of sudden emergence of a new phenomenon, the University can see the importance of other research institutions; as third-party research institutions (universities and research institutions) than to focus more on basic science research enterprise that enterprise more emphasis on innovative research to improve existing products, especially product quality improvement and cost reduction on. Therefore, new technologies or new businesses should emphasize the participation of third-party research organizations [48]. Most technologies coming out of universities are at the early stages of development [60]. The commercialization of such emerging technologies often takes a long time, while the development of this stage is usually a sudden correction or refining conditions, and further develop firm business new model's [20]. This study shows that when business has the need for external organizations to participate in research and development, the individual organizations participating in product design performance have a positive influence on the results. However, when the company involves third-party suppliers and research institutions in new product development, the effect was less significant. This result agrees with the previous study, showing that when the basic research expertise of universities and research institutions is applied to the interaction of suppliers, it is less effective. This study suggests that for enterprises wishing to improve the quality of existing products or decrease supplier costs using technical knowledge, improving product design performance will be a significant help. However, care must be taken when introducing the basic scientific research of third-party researchers due to differing objectives, schedules, and cognitive differences. Future studies should examine different product innovation and industry life cycles to confirm if this difference really exists. Future research should pay attention to outside organizations to import unit is worth further study, such as new technology development expertise of third-party organizations

find someone to help identify until after the theme, let supplier involvement and supplier based on the established themes, please continue and third-party groups, so may narrow the gap between practice and theory of knowledge, and thus get a better product innovation performance. Future studies may extend this concept using other methodologies and sources of information.

This study focuses on the effects of manufacturing industry suppliers, customers, and third parties on product innovation performance, and is not applicable to all industries. For example, it is not applicable to the hot topic of service innovation. Future research on this topic should examine the service industry or non-profit organizations, and explore the effects that external organizations have on innovation performance. Secondly, in addition to the moderating variable of third party that is employed in this study, future research should consider other variables or mechanisms, such as the discovery by De Luca and Atuahene-Gima (2007) [17] that knowledge integration mechanisms have a moderating effect on product innovation performance in inter-functional cooperation. Further research could examine inter-organizational collaboration and innovation performance. Lastly, we would like to point out the generalizability of these finding. Although the data in this study is limited to Taiwan, the patterns of collaboration in Taiwan are similar to those of the China.

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# APPENDIX

| Construct and Source | Operational Measures of Construct |
|---|---|
| Design performance [46] | ● This collaboration resulted in a design that was easier for the supplier to execute than if the supplier had not been integrated.<br>● This collaboration resulted in a design that was less costly for the supplier to execute than if the supplier had not been integrated. [a]<br>● The external organization involvement in this collaboration resulted in a better design of the procured item.<br>● The external organization involvement in this collaboration resulted in a better design/technology for the finished product. |
| Market performance [32] | The external organization involvement in this collaboration enabled more<br>● sales goals. .<br>● Customer acceptance.<br>● Customer satisfaction.[a]<br>● market share goals. |
| Supplier involvement [34, 57, 64] | ● Suppliers involved in early stage of product development<br>● Supplier input for parts design [a]<br>● Product development people meet supplier<br>● Supplier input for prototype test |
| Customer involvement [34] | ● Customer involved in early stage of product development.<br>● We use information from customer.<br>● We use customers as source of ideas<br>● We listen to our customers needs.<br>● Product development people meet customer. [a] |
| Third parties involvement (New scale) | ● Third parties involved in early stage of product development.<br>● We use information from Third parties.<br>● Third parties input for prototype test<br>● Product development people meet Third parties people.<br>● Third parties input for parts design |
| Technology uncertainty [31] | ● The technology in our industry is changing rapidly.<br>● A large number of new product ideas have been made possible through technological breakthroughs in our industry.<br>● There are major technological development in our industry. |
| Market uncertainty [31] | ● Customer in our industry tend to look for new product all the time.<br>● New customers tend to have product needs that are different from those of existing customers.<br>● We are witnessing demand of our products from customer who never bought us before. |

[a] Items deleted from scale

# 供應鏈夥伴涉入新產品發展之影響：第三方參與的調節效果

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## 摘要

新產品發展的速度是企業取得競爭優勢的重要因素，而供應鏈夥伴等外部成員參與新產品發展活動則是企業相當重要的策略概念。本研究調查208家台灣製造業廠商，探討供應鏈夥伴與第三方涉入對產品創新績效的影響。結果發現，供應鏈外部成員涉入都會正向影響產品創新績效，而第三方涉入是供應鏈之外部成員涉入與產品創新績效之間重要的調節因素，其對顧客涉入與產品市場績效之間產生正向調節效果，但對供應商涉入與設計績效之間產生負向調節效果，原因可能是供應商與第三方機構的知識基礎上之差異。

**關鍵詞：**供應鏈管理、新產品發展、第三方涉入、產品創新績效
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