In an increasingly competitive global marketplace, most firms are competing with a high level of market pressure worldwide. In the context of supply chain management, it is necessary for industry to develop supply chain networks of activities involved in producing and delivering a final product from suppliers to end customers. However, effective and efficient supply chain management requires integrated business processes that go beyond purchasing and logistics activities. By integrating closely with suppliers and customers, firms can improve product quality in order to remain competitive. While supply chain integration is definitely crucial for supply chain management, some doubts are expressed concerning the applicability of supply chain integration practices. Specifically, a careful literature search reveals that no studies have included the effect of environmental uncertainty on the relationship between supply chain integration and product quality. This study, therefore, represents an attempt to provide the contribution in the field by developing a model to explore the relationships and to fulfill the gap between the literature on supply chain integration and environmental uncertainty. The findings indicate that the effects of supply chain integration on product quality are moderated by environmental uncertainty as demonstrated by Chow tests. The results also provide managerial insights about environmental uncertainty-supply chain integration practices connection.

Abstract - Although effective and efficient supply chain management requires integrated business processes that go beyond purchasing and logistics activities, some doubts are expressed concerning the applicability of supply chain integration practices. Specifically, a careful literature search reveals that no studies have included the effect of environmental uncertainty on the relationship between supply chain integration and product quality. This study, therefore, represents an attempt to provide the contribution in the field by developing a model to explore the relationships and to fulfill the gap between the literature on supply chain integration and environmental uncertainty. The findings indicate that the effects of supply chain integration on product quality are moderated by environmental uncertainty as demonstrated by Chow tests. The results also provide managerial insights about environmental uncertainty-supply chain integration practices connection.

Keywords - Supply chain integration, Environmental uncertainty, Automotive industry, Thailand

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aspects of supply chain integration might be important under different circumstances. Hence, there is still a need for more research to investigate the effect of environmental uncertainty on the relationships between supply chain integration practices and product quality. Further empirical analysis seems necessary to investigate the relationship between environmental uncertainty as a contingency factor in determining supply chain integration structure and firm performance.

This study emphasizes that the contingency factor as the environmental uncertainty is important to the effect of supply chain integration on product quality. This paper posits the following research question: To what extent does the environmental uncertainty moderate the relationship between supply chain integration and product quality? This study, therefore, represents an attempt to provide the contribution in the field by developing a model to explore the relationships and to fulfill the gap between the literature on supply chain integration and environmental uncertainty. Since there has been little research recognizing the value of the effect of uncertainty on the relationship between supply chain integration and product quality. As a result, it takes the next step to understand how management of supply chain integration is performed under various circumstances.

**Literature Review**

**Supply Chain Integration**

The development of supply chain integration includes three stages from strategic to tactical and then to operational perspectives (Steven 1989). Strategic perspective establishes a framework for the supply chain in terms of what the supply chain has to do well, and ensures a support to the business. Tactical perspective involves the means by which the strategic objectives can be realized and translated into goals and objectives for each function in the supply chain. Moreover, the tactical perspective includes the tools related to organizational structure, technologies, systems, and infrastructure. Operational perspective represents the efficient operation of the supply chain. Steven (1989) also classifies supply chain integration into three levels from functional integration, to internal integration, and to external integration. However, this study focuses only on internal and external integration because the functional integration is claimed as a basic requirement that all firms should implement and achieve.

1) **Internal integration**

To best support customer requirements at the lowest total system cost, internal integration represents the integration of all internal functions from material management to production, sale, and distribution (Morash et al. 1997). At this stage, the firm focuses not only on the internal flow of goods into the organization, but also on the way out to the customer. Moreover, the internal integration is characterized by full systems visibility from distribution to purchasing, and required integration across functions under the control of the firm to achieve customer satisfaction. In practice, it means that special attention must be given to the interface between functional areas such as procurement, production, logistics, marketing, sale, and distribution (Steven 1989; Morash et al. 1997).

2) **External integration**

In terms of customer integration, the firm will penetrate deep into the customer organization to understand the product, culture, market and organization so that it can respond rapidly to the customer’s needs and requirements. The important concept of customer integration is based on the improvement of demand planning and visibility in supply chains (Fisher et al. 1994). Without information sharing from one end of the supply chain to the other, it can lead to tremendous inefficiencies in customer service. Many studies have considered the classification of customer-side integration in various dimensions. For instance, Frohlich and Westbrook (2001) evaluate customer integration using the following issues: 1) efficient delivery, 2) delivery/logistics communication, 3) speed of delivery/route, 4) inventory stocking points, and 5) demand planning.

For the supply integration, integration back down to the
suppliers represents a change in attitude, away from conflict to cooperation starting from product development, supply high quality products, process and specification change information, technology exchange, and design support. Some researchers have investigated the supply-side integration in different dimensions. Handfield (1993) defines supply integration as obtaining frequent deliveries in small lots, using single or dual sources of supply, evaluating alternative sources on the basis of quality and delivery instead of price, and establishing long-term contracts with suppliers. In terms of logistics communication, Ragatz et al. (2002) view supply integration as the effective alignment, information sharing, and supplier participation between suppliers and manufacturers.

3) Environmental uncertainty

Environmental uncertainty has been defined on the basis of the concept of uncertainty. Duncan (1972) views that uncertainty can consist of the following three components: 1) the lack of information regarding the environmental factors associated with a given decision-making situation, 2) not knowing the outcome of a specific decision in terms of how much the organization would lose if the decision were incorrect, and 3) inability to assign probabilities with any degree of confidence as to how environmental factors are going to affect the success or failure of the decision unit in performing its function. According to Lenz (1980), environmental uncertainty can be defined as the source of events and changing trends that create opportunities and threats for individual organizations. As Ettlie and Reza (1992) point out, environmental uncertainty can also be viewed as unexpected changes of customers, suppliers, competitors, and technology. The same classification of environmental uncertainty is adopted in Li et al.’s (2005) study of integrated model for supply chain management. Consistent with this perspective, this study considers environmental uncertainty as the perspective of uncertainty on customers, suppliers, competitors, and technology. This framework represents the core concept of environmental uncertainty, and allows identifying and analyzing the influence of uncertainty in supply chain management practice.

Customer uncertainty is defined as the extent of change and unpredictability of customer’s needs and demands (Zhang et al. 2002). Faced with environmental uncertainty and increased competition, markets are becoming more international, dynamic, and customer driven. Customers are more sophisticated. They demand more variety, higher quality, and better product (Claycomb et al. 1999). It is becoming more important to develop new products effectively than to produce old product effectively. Being efficient is no longer enough, customers want better product with faster delivery. Geary et al (2002) state that customer uncertainty can be viewed as the difference between the actual end-marketplace demand and the orders placed with an organization by its customers. It can be measured in terms of how well companies meet customer demand. For instance, customers place orders twice the typical order size, resulting in poor on-time delivery or fill rate performance. Moreover, customer uncertainty can be defined as the link to the predictability of the demand for the product. For example, products which are characterized as high demand variability, difficult to forecast, irregular purchase, high innovative and short life cycle have highly customer uncertainty in terms of product options and volume (Chang 2002). In terms of product features, Garvin (1988) also points out that it is important for firms to offer more customized products to meet specific customer’s needs. Due to this customer pressure, the requirement for flexibility and mass customization that emphasizes flexibility and small batch production has been developed.

Supply uncertainty is defined as the extent of change and unpredictability of the suppliers’ design, quality and delivery performance. Uncertainty caused by suppliers, such as late delivery, machine broke down, quality of incoming material or parts, and degree of inconsistency will postpone or delay a manufacturing process. This uncertainty can lead to increasing inventory cost which could propagate throughout the whole network. Geary et al. (2002) consider supply uncertainty as the results from poorly performing suppliers not meeting organization’s needs. Supply uncertainty can also be evaluated by looking at supplier’s delivery performance, time series of order placed, actual lead-times, and supplier quality reports. Effective supply-based activities
can contribute to higher level in performance. For example, supplier involvement has a significant impact on return on assets (ROA) and growth (Tan et al. 1999). A manufacturer with poor performance supplier will find it very difficult to provide high levels of customer service. Lee (2002) points out that supply uncertainty can be viewed as evolving supply process where the manufacturing process and the underlying technology are still under early development and are rapidly changing. Consequently, suppliers may be limited in both size and experience. In evolving supply process, supply uncertainty can be evaluated as the dimensions including potential quality problem, unreliable suppliers, inflexibility or difficulty of changeover and variable lead time. Similarly, in the study of Chang et al. (2002), they construct supply uncertainty by considering the unpredictability degree of four factors including improvement of vendor quality as requested, possibility of increasing vendor production capacity, possibility of changing vendor delivery date, and possibility of vendor quality variation. In addition Li (2002) assesses supply uncertainty by providing factors such as unpredictability of engineering level, product quality, delivery time, and quantity.

Competitor uncertainty is defined as the extent and unpredictability of the competitors’ actions (Li 2002). Globalization and demanding customers increase the level of competency in business. Organizations that focus on domestic markets must be able to understand foreign rivals that penetrate their markets. As a result, firms have no choice but to develop global perspective of competition by recognizing the entry of new competitors and the necessity of partnership with other organizations. This competition is forcing firms to rearrange their business strategies away from conventional, cost-based strategies to knowing which feature a customer wants. Jones and Ryan (2002) suggest that firms cannot operate in such a static environment. Even in a stable market, business may be exposed to periodic "shocks" that can move a firm up to high competition. In the case of Caterpillar and Komatsu, two global companies in the construction equipment industry, Caterpillar operated in a stable environment until the 1980’s. Then, Komatsu began taking over the market share by offering products with similar performance at a much lower price. For this reason, Caterpillar forced a movement towards more organic strategies. The literature has suggested how to operationalize competitor uncertainty. For example, Chang et al. (2002) suggest three factors regarding possibility and predictability of competitors changing: 1) price, 2) marketing strategies, and 3) entry/exit of new/current competitors. Similar to the Chang et al. (2002) study, Li (2002) provides the measurement including the possibility of competitors to introduce new product unexpectedly, enter form different sectors/countries, and unpredictable actions.

Technology uncertainty is defined as the extent of changes and unpredictability of product and process technology development. The development of technology provides numerous opportunities for organizations. For example, companies apply new technology to offer various products to take advantage of new opportunities. New market opportunities come with technological innovation. As technology becomes more multidisciplinary and dynamic, firms are relying on other firms as a way to attain the technological know-how necessary as parts of their supply chain restructuring programmes. Additionally, developments in information technology enable companies to achieve a degree of control in international supply chains. Advanced information technology can also reduce transaction costs relating to the control of goods flows and the making of a quick response to customer orders. Ragatz et al. (2002) suggest that technology uncertainty can be measured as the degree to which the product or process technologies employed are new, complex, and/or rapidly changing. In terms of product technology uncertainty, Chang et al. (2002) include two variables: 1) change of core production technology, and 2) change of supporting technology. Technology uncertainty can also be viewed as how significantly changing of technology in particular industry, and technology breakthrough resulting in new product development.

Hypotheses Development

Environmental Uncertainty as a Moderating Effect

The environmental uncertainty could influence the relation-
ship between supply chain integration and firm competitive capability. As suggested by Lee (2002), a product with a stable demand and a reliable source of supply should not be managed in the same way as one with a highly unpredictable demand and an unreliable source of supply. To further explain, automotive industry provides an appropriate example. It is expected that this industry with high level of supply uncertainty will affect the supply integration strategy on product quality performance more than other industries with low supply uncertainty. To support this assumption, Hrebiniak and Snow (1980) and Fisher (1997) indicate that uncertainty will vary by product sector or industry. Some uncertainty characteristics require supply chain strategies that can provide a competitive edge to companies. In addition, Stonebraker and Afifi (2004) suggest that different types and amount of supply chain integrative efforts are appropriate in different situations. Therefore, the effect of supply chain integration on product quality capability may indeed be different under various models, depending on environmental uncertainty. Therefore, the following hypotheses were proposed:

H1) Supply uncertainty has a moderating effect on the relationship between supply chain integration and product quality.

H2) Customer uncertainty has a moderating effect on the relationship between supply chain integration and product quality.

H3) Technology uncertainty has a moderating effect on the relationship between supply chain integration and product quality.

H4) Competitor uncertainty has a moderating effect on the relationship between supply chain integration and product quality.

Methodology

Survey Instrument and Data Collection
The instrument used to test the hypotheses was a mail survey. This study used five-point Likert scale for all constructs to draft a questionnaire. This draft questionnaire then was pre-tested with academics and practitioners to check its content validity and modified accordingly. The modified questionnaire was pilot-tested to examine its suitability for the target population before large-scale mailing.

Empirical data was obtained through a mail survey to production or purchasing managers, who had knowledge of supply chain management practices. These respondents were asked to rate their firms relative to their understanding on supply chain integration, environmental uncertainty, and product quality performance. The unit of analysis in this study was limited to plant level. Within this perspective, Flynn et al. (1994) point out that most empirical research in operations management occurs at the corporation or individual level of analysis. Moreover, the independent variables of supply chain management practices usually reflect corporate level practices. Similarly, the dependent variable of firm competitive capability also reflects the corporate level results.

The survey was selected specifically to automotive industry in Thailand because of the following reasons. First, automotive industry is seen as an indicator to measure the wealth of the economy. Second, the literature in automotive supply chain has been well documented in previous research, and there is a clear structure of automotive supply chain. Finally, automotive sector has been a leader in implementing supply chain management strategies in Thai industry. We forwarded the questionnaire with a cover letter indicating the purpose of this study to 403 qualified first-tier suppliers and automakers. After six weeks, we received 91 completed responses following 20 questionnaires returned as the second wave. The total 111 responses were returned to the response rate of 27.5%.

Non-Response Bias
In this study, non-response bias was evaluated using the method suggested by Armstrong and Overton (1977). This method tested for significant different between early and late respondents, with a late respondents being considered as a non-respondent. By using this method, although it did not investigate non-response directly, a comparison was made between those subjects who responded in the first
Data Analysis

Instrument’s Validity and Reliability

As new items were being used, an exploratory factor analysis (EFA) of the items in each constructed was conducted using a Varimax rotation to reduce the number of items. EFA is useful in discovering potential latent source of variance and covariance in observed measurement. Items with good measurement properties should show high factor loading on the factor of which they are indicators, while small factor loading on the factor that are measured by different sets of indicators. Therefore, this result can provide an evidence of initial construct validity.

In this sense, validity is defined as the extent to which the instrument captures what it is intended to capture. According to Nunnally (1978), to test the construct validity, the EFA is used to assess either inter- or intra-scale differences, and established by the following decision rules including: 1) minimum Eigenvalues of 1; 2) the value of 0.5 was used as the cutoff score for factor loading. In addition, the items with serious cross loading, which means the items loaded very close to 0.5 on more than one factor. In this study, factor loadings lower than 0.4 were removed in order to streamline the final result. In addition, the Kaiser-Mayer-Olkin (KMO) measure and Bartlett’s test of sphericity were tested to ensure that the data had inherent sufficient correlations to perform EFA. The KMO index was 0.80, and Bartlett’s test of sphericity was significant at a level of 0.00, which justified the use of EFA.

To begin, the factor structure of each scale for supply chain
integration, environmental uncertainty, and competitive capability was explored by conducting a factor analysis on each scale individually. For each the items loaded on only one factor, with total variance extracted exceeding 50 percent in all cases. The reliability of each scale, measured internal consistency using Cronbach $\alpha$, was above the recommended threshold of 0.7 (Nunnally 1978). The EFA loading, Eigenvalue, percentage of variance explains, KMO index, Bartlett’s test of sphericity for all items are available at the Appendix A.

1) Supply chain integration

As the independent variables, the internal integration factor explained 66.3% of the variance with all its four items loading on a single factor with loading ranging between 0.716 and 0.857. The scale Cronbach’s alpha was 0.83. In addition, the factor of supply integration explained 72.2% of variance with all its three items loading ranging between 0.748 and 0.840. The scale Cronbach’s alpha was 0.808. Besides both internal and supply integration, the factor of customer integration explained 68.85% of variance with all its three items loading between 0.701 and 0.836. The Cronbach’s alpha of this factor was 0.765.

2) Environmental uncertainty

Based on results from factor analysis, there are four factors of types environmental uncertainty in this study. It can be seen that all items loaded on their respective dimensions, with most loading greater than 0.60. The cumulative variance explained by four dimensions is well in excess of 50%. In addition, the Cronbach’s alpha of supply uncertainty, customer uncertainty, competitor uncertainty, and technology uncertainty are 0.839, 0.767, 0.727, and 0.730 respectively.

3) Product quality

The dependent variable in this study is product quality performance. According to the same recommended value to test scale validity and reliability used in the previous constructs. The cumulative percentage of variance explained for product quality construct was well in excess of 50%, showing 71.87%. In addition, reliability was tested using Cronbach’s alpha for each factor. The reliabilities of product quality construct showed satisfactory scores, representing 0.899

Results and Discussion

This study focuses on the moderating effects of four contingency variables on product quality through three dimensions of supply chain integration. These four variables are: supply uncertainty, customer uncertainty, technology uncertainty, and competitor uncertainty. The Chow test has been often employed to test whether there is a structural change between two groups by examining the statistical significance of the difference in the size of regression coefficients (Chow 1960). Based on the previous studies in operations management research (e.g., Hope and Muhlemann 2001; Fynes and Voss 2002; Bstieler and Gross 2003; Fam and Yang 2006), these authors also use Chow test to examine the stability of the regression coefficient across two sub-groups. Thus, the Chow test is an appropriate methods to test if the above four variables have a moderating effect on firm competitive capability. All responses were divided into two groups based on each of four variables into high and low groups, which are below and above the composite means of the four contingency variables in order to assess the impact of supply chain integration on product quality using multiple regression analysis.

As presented in Table 1, F-statistics for technology uncertainty and competitor uncertainty were significant at 0.05 levels in the case of product quality. Specifically, the results show that firms which faced low technology uncertainty, internal integration positively impacted product quality. In contrast, for the sub-group of firms facing high technology uncertainty, supply integration was the primary factor to product quality. In the case of competitor uncertainty, only for firms reporting low uncertainty does supply integration predict product quality, while internal integration positively impact product quality for firms facing high competitor uncertainty. As the evidence shown in Chow tests, it is also noteworthy that supply uncertainty and customer uncertainty are not significantly different between two sub-groups of
environmental uncertainty variables. It appeared that only technology uncertainty and competitor uncertainty were significant contingency variables. Therefore, hypothesis 3 and 4 are supported.

An examination of the relationship between supply chain integration and product quality for firms reporting low and high environmental uncertainty yields the following results. Overall, this present study indicates that the effects of supply chain integration on product quality are moderated by environmental uncertainty as demonstrated by Chow tests. More specifically, only firms facing low technology uncertainty, internal integration and customer integration show a significant impact on product quality, while in a case of high technology uncertainty only supply integration shows a significant effect on product quality. An explanation for this finding lies in the action of firms when faced with high technology uncertainty may be more reluctant to integrate internally and collaborate to customers since technologies become obsolete quickly and new products are introduced frequently. Hence, the integrative business processes among departments and with customers should be less than when technology obsolescence is slow. Among firms reporting low competitor uncertainty, only supply integration predicts product quality, where as among firms facing high competitor uncertainty internal integration predicts product quality. It may imply that firms prefer not to integrate to their suppliers in a highly competitive environment. In contrast, decentralization or internal integration practices are needed to emphasize in order to survive in a highly competitive environment.

These moderating factors should be considered of potential interest to researchers and practitioners. Moreover, the results shed some light on the relative degrees of significance of the environmental uncertainty variables. This result is consistent with the results in previous studies (e.g., Zacharia and Mentzer 2004; Fynes et al. 2006). In Fynes et al.’s research (2005), the interaction between supply chain relationship quality and environmental uncertainty on supply chain performance is very significant.

However, the findings of this study contradict the idea that firms must develop supply chain integration practices to deal with high environment uncertainty (Buvik and John 2000). In contrast, for firms reporting high uncertainty, supply chain integration mostly does not impact product quality. The findings could be explained by the following arguments. First, effective implementation of supply chain integration practices especially in automotive industry will need the existence of commitment, shared visions among internal functions as well as suppliers and customers under stable business environment. In other words, the empirical results of this study demonstrate that obtaining favorable results in product quality is based on building the effective relationship with business partners under low environmental uncertainty. This finding supports the work of Morris and Carter (2005), who suggest that firms should invest their resources in both reducing uncertainty and increasing cooperation in their relational exchanges. Second, management in firms operating in high uncertainty may be more reluctant to integrate internally and externally to their business partners since those integrative supply chain practices under condition of low uncertainty may be viewed as more strategic than they are under conditions of high uncertainty. In other words, firms may emphasize their supply chain integration practices only on the condition of low uncertainty, but not prepare themselves for high uncertainty condition. As a result, it is not likely to see the significant relationship between supply chain integration and product quality under high environmental uncertainty.

The results of this study pinpoint an important implication for practitioners by highlighting the importance of environmental uncertainty in implementing supply chain integration. Although firms have tended to focus on integrative supply chain practices, they have not given enough attention to the effect of external factors such as environmental uncertainty. The results of this study demonstrate to the practitioners that to achieve high level of product quality through supply chain integration, spending time and effort understanding types of uncertainty before investing in supply chain integration is a must. The basic concept is that the implementation of supply chain integration is not rigid. Rather, a success is attributable to the way in which supply chain integration practices are combined and organized based on the uncertainty or business condition factors.
In terms of research contribution, the results obtained in this study empirically confirm that different business environments require different supply chain integration practices on firm competitive capability. If the supply chain integration strategy is inappropriate to the level of differentiation, it would be a reason for increased supply chain costs, and in the long run suggest potential failure (Stonebraker and Afifi 2004). In regards to implications for managers, firms need to choose the specific supply chain integration strategy on developing product quality under different circumstances. The results provide managerial insights about environmental uncertainty-supply chain integration practices connection.

REFERENCES


Jones, R.T. and Ryan, C. (2002). Matching Process Choice and


### Appendix A1
Constructs, Variables, Factor Analysis and Internal Consistency for Supply Chain Integration

<table>
<thead>
<tr>
<th>Internal Integration (II)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>II1</td>
<td>We have a high level of responsiveness within our plant to meet other department’s needs</td>
</tr>
<tr>
<td>II2</td>
<td>We have an integrated system across functional areas under plant control</td>
</tr>
<tr>
<td>II3</td>
<td>Within our plant, we emphasize on information flows among purchasing, inventory management, sales, and distribution departments</td>
</tr>
<tr>
<td>II4</td>
<td>Within our plant, we emphasize on physical flows among production, packing, warehousing, and transportation departments</td>
</tr>
</tbody>
</table>

Percentage of variance = 66.3, Internal consistency ($\omega$) = 0.83

### Supply Integration (SI)

<table>
<thead>
<tr>
<th>Supply Integration (SI)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI1</td>
<td>We share information to our suppliers through information technologies</td>
</tr>
<tr>
<td>SI2</td>
<td>We have a high degree of strategic partnership with our suppliers (i.e. single/dual sourcing of supply with long-term relationship)</td>
</tr>
<tr>
<td>SI3</td>
<td>Our plant has a high degree of joint planning to obtain rapid response ordering process (inbound) with our suppliers</td>
</tr>
<tr>
<td>SI4</td>
<td>Our suppliers provide information to us in the production and procurement processes</td>
</tr>
<tr>
<td>SI5</td>
<td>We obtain efficient and reliable delivery (inbound) from suppliers.</td>
</tr>
<tr>
<td>SI6</td>
<td>Our suppliers are involved in our product development processes</td>
</tr>
</tbody>
</table>

Percentage of variance = 72.2, Internal consistency ($\omega$) = 0.808

### Customer Integration (CI)

<table>
<thead>
<tr>
<th>Customer Integration (CI)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI1</td>
<td>We share information to our customers through information technologies</td>
</tr>
<tr>
<td>CI2</td>
<td>Our plant has a high level of information sharing with our customers about market information</td>
</tr>
<tr>
<td>CI3</td>
<td>We have a high degree of joint planning and forecasting with our customers to anticipate demand visibility</td>
</tr>
<tr>
<td>CI4</td>
<td>Our customers provide information to us in the procurement and production processes</td>
</tr>
<tr>
<td>CI5</td>
<td>Our customers are involved in our product development processes</td>
</tr>
</tbody>
</table>

Percentage of variance = 68.85, Internal consistency ($\omega$) = 0.765

### Appendix A2
Constructs, Variables, Factor Analysis and Internal Consistency for Environment Uncertainty

<table>
<thead>
<tr>
<th>Supply Uncertainty (SU)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>SU1</td>
<td>Our suppliers’ delivery performance is unpredictable</td>
</tr>
<tr>
<td>SU2</td>
<td>Our suppliers’ quality performance is unpredictable</td>
</tr>
<tr>
<td>SU3</td>
<td>Our suppliers’ product design performance is unpredictable</td>
</tr>
<tr>
<td>SU4</td>
<td>Our suppliers often change their production capacity.</td>
</tr>
<tr>
<td>SU5</td>
<td>We involve supply process when our suppliers are still under development</td>
</tr>
</tbody>
</table>

Percentage of variance = 78.21, Internal consistency ($\omega$) = 0.839

<table>
<thead>
<tr>
<th>Customer Uncertainty (CU)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU1</td>
<td>Our customers often order customized products to meet their specific needs</td>
</tr>
<tr>
<td>CU2</td>
<td>Our customers’ requirements regarding product or part preferences often change</td>
</tr>
<tr>
<td>CU3</td>
<td>Our customers often change their order over the month</td>
</tr>
<tr>
<td>CU4</td>
<td>Our customers often change their delivery date over the month</td>
</tr>
<tr>
<td>CU5</td>
<td>The difference in time between the actual delivery date and the orders placed by customer is unreliable</td>
</tr>
</tbody>
</table>

Percentage of variance = 62.93, Internal consistency ($\omega$) = 0.707

<table>
<thead>
<tr>
<th>Technology Uncertainty (TU)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>TU1</td>
<td>Process technologies employed in our plant are complex</td>
</tr>
<tr>
<td>TU2</td>
<td>Our plant uses core production technologies that often change</td>
</tr>
<tr>
<td>TU3</td>
<td>Product technologies employed in our plant are complex</td>
</tr>
<tr>
<td>TU4</td>
<td>Our plant uses core supporting technology that often change</td>
</tr>
<tr>
<td>TU5</td>
<td>Our plant uses technology that has short technology life cycle</td>
</tr>
</tbody>
</table>

Percentage of variance = 73.24, Internal consistency ($\omega$) = 0.727

<table>
<thead>
<tr>
<th>Competitor Uncertainty (COMU)</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMU1</td>
<td>Competitors offer lower prices that change over the year</td>
</tr>
<tr>
<td>COMU2</td>
<td>Competitors’ actions regarding marketing promotions are unpredictable</td>
</tr>
<tr>
<td>COMU3</td>
<td>Competitors often introduce new products features frequently</td>
</tr>
<tr>
<td>COMU4</td>
<td>Competitors’ actions regarding changing in entry/exit of new or current competitors are unpredictable</td>
</tr>
</tbody>
</table>

Percentage of variance = 68.84, Internal consistency ($\omega$) = 0.730

KMO measure of sampling adequacy = 0.76, Bartlett’s test of sphericity (significant level) = 0.00
### Appendix A3

Constructs, Variables, Factor Analysis and Internal Consistency for Supply Chain Integration

<table>
<thead>
<tr>
<th>Product Quality</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQ1 We offer high performance products that meet customer needs</td>
<td>0.833</td>
</tr>
<tr>
<td>PQ2 We are able to produce consistent quality products with low defects</td>
<td>0.627</td>
</tr>
<tr>
<td>PQ3 We offer high reliable products that meet customer needs</td>
<td>0.807</td>
</tr>
<tr>
<td>PQ4 We offer high quality products that meet our customer needs</td>
<td>0.792</td>
</tr>
</tbody>
</table>

Percentage of variance = , Internal consistency (a) =

KMO measure of sampling adequacy = 0.92, Bartlett’s test of sphericity (significant level) = 0.00
[한국어 요약(Korean Abstract)]

글로벌 경쟁이 심화되어 공급사를 효과적으로 운영해야 할 필요성이 높아지고 있다. 단지 부품을 효율적으로 구매하고, 물류를 개선하는 것이지만 아니라 품질을 높여 경쟁력을 향상시키기 위해서도 부품업체에서부터 소비자까지 이어지는 모든 프로세스가 통합적으로 관리되어야 한다. 자동차산업의 경우, 완성차업체들이 공급사를 통합 필요성을 인식하고 있으나 경영환경의 불확실성으로 인해 실제 적용에는 어려움을 겪고 있다. 뿐만 아니라, 환경 불확실성(environmental uncertainty)이 가치사슬 통합과 품질 간의 관계에 미치는 영향에 대한 연구도 많지 않은 실정이다.

본 연구는 조절(moderator)변수인 환경적 불확실성에 따라 태국 자동차산업의 가치사슬 통합이 제품 품질에 어떠한 영향을 주는지를 살피고 있다. 태국 자동차산업은 타 산업에 비해 공급자 불확실성이 높아 연구에 적합한 측면이 있다. 한편, 가치사슬 통합을 다루는데 있어, 가치사슬 통합을 분류하는 전략적 관점, 전술적 관점, 운영상의 관점 중 운영상의 관점으로 한정하였다. 또한, 운영상의 관점 중 업체가 기본적으로 추진하는 기능적 통합은 제외하고 내외부 통합으로 한정하였다. 내부 통합은 생산, 판매, 유통 등 기업 내부 기능의 통합을 의미하고, 외부 통합은 소비자 만족 극대화를 위한 소비자 통합과 비용절감 및 효율성을 높이기 위한 공급업체 통합을 의미한다. 독립변수로서 가치사슬 통합은 내부 통합, 소비자 통합, 공급업체 통합 등 3가지 측면에서 분석하였다.

조절변수로서 환경 불확실성을 고객 불확실성, 공급업체 불확실성, 경쟁자 불확실성, 기술 불확실성으로 구분하여 분석하였다. 고객 불확실성은 고객의 니즈 및 수요 변동을 의미하며, 공급업체 불확실성은 공급업체의 딜레이, 품질, 운송의 변화를 의미한다. 경쟁자 불확실성은 경쟁자 행동의 예측 불가능성을 의미하고, 마지막으로 기술 불확실성은 제품 기술 및 프로세스 기술 개발의 변화와 관련된 것이다. 실험분석을 위해 공급사슬 관계에 대한 통합을 측정한 생산, 구매 담당자들에게 75점 척도 설문지를 우편으로 송부해 자사 공급사슬 통합, 환경적 불확실성 및 품질을 평가하도록 하였다. 총 403개 중 111개 설문지가 회수되었다. 조절변수의 정도에 따라 응답자를 두 그룹으로 나누어 독립변수와 종속변수와의 관계를 다중회귀분석과 쇼우 테스트(Chow test)로 분석하였다.

연구 결과, 기술 불확실성과 경쟁자 불확실성 변수가 유의미한 것으로 나타났다. 기술 불확실성이 낮은 경우에는 내부 통합과 고객 통합이 품질에 영향을 미친 반면, 기술 불확실성이 높은 경우에는 공급업체 통합이 품질에 영향을 주었다. 이를 해석하면, 신기술 개발 속도가 빨라지면 완성차업체들은 부서 간 프로세스 통합과 고객과의 통합을 향상시켜야 한다는 것이다. 경쟁자 불확실성이 낮을 때 공급업체 통합이 제품 품질에 영향을 주고, 경쟁자 불확실성이 높을 때 내부 통합이 품질에 긍정적인 영향을 주었다. 이는 경쟁이 심화될 때 완성차업체들이 부품업체와 통합하지 않고, 분권화 혹은 내부 통합을 추진한다는 것을 의미한다.

본 연구는 완성차업체가 처해있는 경영환경에 따라 각기 다른 공급사슬 통합 전략을 취해야 함을 실증연구로 밝혔다는 점과 환경적 불확실성 요인, 공급사슬 통합, 제품 품질 간의 관계를 설명하는 연구모델을 개발하였다든 점에서 학문적·실무적 의미가 있다.
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