SUPPLY CHAIN MANAGEMENT PERFORMANCE IMPACTS OF SUPPLY CHAIN STRATEGY, INFORMATION SYSTEM STRATEGY AND ENVIRONMENTAL UNCERTAINTY: A CONTINGENCY PERSPECTIVE

Wen-Jin Hwang\textsuperscript{a*}, Chang-Yao Wu\textsuperscript{b}, Meng-Hsiang Hsu\textsuperscript{b}

\textsuperscript{a}Department of Business Administration, Kun Shan University, #949, DaWan Rd., Yong Kang Tainan 71003, Taiwan
\textsuperscript{b}Institute of Management, National Kaohsiung First University of Science and Technology, #2, Juoyue Rd., Kaohsiung 811, Taiwan

*Corresponding Author: james@mail.ksu.edu.tw

ABSTRACT
A right supply chain (SC) strategy is widely believed to be able to improve supply chain management (SCM) performance. Through implementing a right information system (IS), companies in a supply chain could expand both the needs and opportunities for improved SCM. Furthermore, environmental uncertainty usually affects the SC performance and determines which competitive factors should be emphasized and evaluated to help formulate a winning competitive strategy. Ignoring the important concept of alignment, mostly SCM research singly investigated the influence of SC strategy or of IS strategy on SCM performance. Consequently, failures in SCM resulting from a mismatch between two or more crucial factors (e.g., SC strategy, IS strategy and environmental uncertainty) remain common. However, empirical research on the topic of co-alignment among a manufacturing firm’s SC strategy, IS strategy, and its environmental uncertainty and the impact of such a co-alignment for SCM performance was extremely sparse in SCM area. To fill this gap, this study proposed a theoretical co-alignment model among SC strategy, IS strategy and environmental uncertainty, and then empirically examined how the co-alignment impacts SCM performance. A survey was used to collect 243 usable responses from manufacturers. A covariation approach was employed to assess the research model. The research results verified that the co-alignment among SC strategy, IS strategy and environmental uncertainty positively enhances SCM performance.

Keyword: Co-alignment, Supply Chain Management, Environmental Uncertainty, Supply Chain Strategy, Information System Strategy

1. INTRODUCTION
Supply chain management (SCM) and related issues has attracted significant attention in recent years, as many manufacturing companies call for efficient and effective
supply chain (SC) to gain a competitive edge in the changing environment (Langfield-Smith and Smith, 2005). Through implementing a right information system (IS), companies in a SC could expand both the needs and opportunities for improved SCM (Lee, 2002). A right SC strategy to implement SCM processes is widely believed to be able to improve SCM performance. For example, Frohlich and Westbrook (2001), from the degree of integration perspective, identified five different SC strategies and found that the widest degree of the arc of integration with both suppliers and customers had the strongest association with performance improvement. Furthermore, environmental uncertainties usually affect the SC performance and determine which competitive factors should be emphasized and evaluated to help formulate a winning competitive strategy (Lee, 2002; Miller, 1993; Paulraj and Chen, 2007; Pollalis, 2003). Fisher (1997) even indicated that the root cause of the problems plaguing many supply chains is a mismatch between type of environmental uncertainty and SC strategy.

For organizational researchers, alignment was treated as an important concept for measuring the performance impacts of environment-strategy alignment (e.g., Venkatraman and Prescott, 1990; Premkumar et al., 2005). Ignoring the important concept of alignment, mostly SCM research singly investigated the influence of SC strategies or information technology (IT) on SCM performance. As a result, failures in SCM resulting from a mismatch between two or more crucial factors (e.g., SC strategy, environmental uncertainty and IS strategy) remain common, and thus the performance of SCM falls below expectations. Lee (2002) further pointed out that managing SC is a complicated task; SC strategies that are based on a one-size-fits-all or try-everything mentality will fail. However, to the best of our knowledge, only few SCM researchers have begun to empirically apply the alignment concept to explore the impact of alignment on improved SCM performance in SCM area (e.g., Selldin and Olhager, 2007; Stock et al., 2000; Sun et al., 2009).

Although the effect of co-alignment on different topics (e.g., business strategy and IS strategy, business strategy and environment, and SCM structure and business strategy) had been empirically investigated and shown to play an important role in business performance (Bergeron et al., 2004; Croteau and Raymond, 2004; Pollalis, 2003; Venkatraman and Prescott, 1990). However, empirical research on the topic of co-alignment among a manufacturing firm’s SC strategy, IS strategy, and its environmental uncertainty and the impact of such a co-alignment for SCM performance was extremely sparse in SCM area.

To fill this gap, a principal research purpose in this study was presented to contribute toward the academic and practice in SCM area. From a holistic perspective, this study empirically tested the effect of co-alignment among SC strategy, IS strategy and
environmental uncertainty on SCM performance by adopting a covariation approach of alignment.

2. THEORETICAL BACKGROUND

2.1 The Concept of Alignment
The underlying conceptual theme of this study is the idea of alignment. Some studies indicated there is a positive relationship between alignment and performance in the context of supply chain (e.g., Stock et al., 2000; Paulraj and Chen, 2007; Lee, 2002). Venkatraman (1989) presented a classificatory framework for identifying six different perspectives of fit/alignment (i.e., moderation, mediation, matching, covariation, gestalts, and profile deviation). Umanath (2003) further grouped fit into three broad types: congruence, contingency, and holistic configuration. This study adopted the perspective of alignment as a pattern of covariation (i.e., internal consistency among a set of theoretical related variables), and treated alignment as a holistic type of fit in order to examine the impact of the co-alignment among SC strategy, IS strategy and environmental uncertainty on SCM performance. According to previous research, this study believed that alignment between SC, IS strategies and environmental uncertainty would have positive influence on SCM performance.

2.2 Supply Chain Management Performance
Defining or adopting a SCM performance metric is not straightforward, due to the abstract formation of the supply chain. Therefore, existing business performance metrics should be revised properly in order to reflect the consequence of implementing any corresponding SC strategies. Brewer and Speh (2000) applied Kaplan and Norton’s (1996) BSC framework to shape a framework of SCM performance measures. Brewer and Speh’s (2000) framework asserts that firms have to strive for SCM profitability and delineates four perspectives of the SCM performance — end customer benefits link to the customer perspective, financial benefits link to the financial perspective, process improvements link to the internal business process perspective, and development improvements link to the innovation and learning perspective. Besides the traditional SC performance measurement approach, Brewer and Speh’s (2000) framework is able to measure not only financial performance but also non-financial, to measure performance across the SC, and to link measures with the SC strategy and customer service. The BSC is used as a strategy implementation tools in many companies and different context (Seuring et al., 2003). In line with Brewer and Speh (2000), this study deals with manufacturing firms SCM performance by applying a BSC framework within the manufacturing
supply chain context.

2.3 Environmental Uncertainty
Assessing or scanning the environment of an organization is necessary in making appropriate decisions and adapting strategies to a context in constant evolution (Bourgeois, 1980). In respect of SCM, Lee (2002) proposed an environmental uncertainty framework for companies within a SC when seeking to devise the right SC strategy. Lee expanded Fisher’s (1997) demand framework to include supply uncertainties, and then formulated four types of environmental uncertainty: low demand and low supply, high demand and low supply, low demand and high supply, and high demand and high supply uncertainties. Demand uncertainty is linked to the predictability of the demand for the product. Fisher (1997) classified products on the basis of their demand patterns into two categories: functional and innovative. Functional products have more predictable demand, and thus have low demand uncertainties. On the contrary, innovative products have the characteristics of higher unpredictable demand. As a result, such products have high demand uncertainties (Fisher 1997; Lee 2002).

Supply uncertainty is another kind of uncertainty revolving around the supply process of the product and is an equally important driver for the right SC strategy (Lee 2002). From both the production and technology aspects, the supply process can be separated into two types: one is stable process and the other is evolving process. A stable supply process is one that the manufacturing process and underlying technology are mature, the supply base is well established, and supply uncertainties are therefore relatively low. Meanwhile, an evolving supply process is one that the manufacturing process and underlying technology are still under early development and are rapidly changing, and the supply base may be limited in both size and experience, thus resulting in high supply uncertainties (Lee 2002).

2.4 Supply Chain Strategy
SC strategy refers to the type/level of integration that should be applied to each business process link (Lambert and Cooper, 2000). Therefore, supply chain strategy can be defined as that strategy a company uses to structure its supply chain (e.g., configuration selection, resource allocation, and process adoption) over the course of time (Chopra and Meindl, 2004) by taking consideration of its supply chain type. Without taking strategic and organizational issues into account, SCM will be limited to an operational approach not very much different from the many already available. Only if cooperation and partnership building is taken as a core element of supply chains will they be able to offer superior customer value with an improved
performance along the supply chain in the long run (Seuring et al. 2003). Therefore, there is a great need for research establishing how, and to what extent SC strategies directly and indirectly shape company performance.

Based on the different environmental nature of demand and supply uncertainties within a SC, Lee (2002) proposed four viable SC strategies: efficient, responsive, risk-hedging, and agile supply chain strategy. Although Lee (2002) presented these four SC strategies to appropriate for different environmental uncertainties, but they only stayed on a paragraph description level. For practitioners, SC strategy along with the articulate contents and emphatic attributes would be very useful to follow and implement in managing a SC. This study thus developed the attributes of the four SC strategies by drawing upon various previous studies focusing on one or more attributes of SC strategy. Based on prior studies (e.g., Cooper and Tracey, 2005; Dehning et al., 2007; Fawcett et al., 2007; Frohlich and Dixon, 2001; Gunasekaran and Ngai, 2004; Lee, 2002; Miller and Roth, 1994; Tracey et al., 2005), this study induced that manufacturing capabilities and IS capabilities are two major critical factors for manufacturing firms within a SC. Frohlich and Dixon (2001) classified manufacturing competitive capabilities into five factors: price, flexibility, quality, delivery, and service. According to these most influential studies (Goh et al., 1997), this study adopted price, flexibility, quality, delivery, and service as five SC strategy attributes.

2.5 Information System Strategy

Information system has been treated as an important factor for formulating business performance and considered as an aid in the evolution of SCM, since the rapid development of SCM software (Semich, 1994). IS strategy can be defined as a crucial plan to realize how companies can use IS to support their strategic objectives and seek competitive advantage from information technology. Many studies have indicated that the effective selection and implementation of information system is a vital facet of a successful SC strategy (e.g., Cooper and Tracey, 2005; Dehning et al., 2007; Fawcett et al., 2007; Gunasekaran and Ngai, 2004; Lee, 2002; Sanders, 2005; Wu et al., 2006). Therefore, this study believes that the IS strategy may affect organizational performance positively in the supply chain as well.

Based on prior studies (e.g., Cooper and Tracey, 2005; Dehning et al., 2007; Fawcett et al., 2007; Gunasekaran and Ngai, 2004; Lee, 2002), this study induced that IS capabilities are critical factors for manufacturing firms within a SC. Regarding IS capabilities within a SC, this study adopted four IS strategy attributes: operational support systems, market information systems, interorganizational systems, and strategic decision support systems from Sabherwal and Chan’s (2001) study to align
with SC strategy and environmental uncertainty of SC. Operational support systems depict the use of IS for monitoring and controlling daily processes to facilitate operational efficiency (Sabherwal and Chan, 2001). Market information systems refer to management information systems but focuses strongly on company markets and product sales (Sabherwal and Chan, 2001). Interorganizational systems represent the use of information system for linking and coordinating with external organizations (Williamson et al., 2004). Strategic decision support systems are related to decision support systems, but with a greater focus on planning, forecasting, modeling of alternatives, and the options to do sensitivity analysis (Sabherwal and Chan, 2001).

3. RESEARCH MODEL AND HYPOTHESIS
Figure 1 illustrates the co-alignment model of SC strategy, IS strategy and environmental uncertainty in this study. Using the perspective of a holistic methodology can make a best understanding on the complexities of how multiple factors intertwine to produce positive business performance (Pollalis, 2003). Recently, many studies have stressed the role of consistency (coalignment) between an organization’s business strategy, business structure, IS strategy, and environmental uncertainty to improve overall firm performance. For example, based on a covariation approach to alignment, Croteau and Raymond (2004) empirically verified that strategic and IT competencies alignment significantly enhances perceived business performance. Bergeron et al. (2001) empirically tested and illustrated the stronger relationship between the firm’s environmental uncertainty, its strategic orientation, its structure, its strategic management of IT, and its performance by means of a coalignment approach. Furthermore, based on a gestalt approach of alignment and theory-based ideal coalignment patterns, Bergeron et al. (2004) empirically validated that the impact of the coalignment between business strategy, business structure, IT strategy, and IT structure was significant on business performance.

Venkatraman and Prescott (1990) argued that a holistic perspective has greater explanatory power rather than a bivariate conceptualization of alignment because of its ability to retain the complex and interrelated nature of the relationships between constructs. As a whole, the same logic was applied for the strategic alignment between IS strategy, SC strategy, and environmental uncertainty in the context of SCM. In line with Venkatraman and Prescott (1990), this study adopted a holistic perspective and suggested a strategic coalignment model by examining three factors that impact firm performance within a supply chain: environmental uncertainty, information system strategy, and supply chain strategy. Therefore, a strategic coalignment model that incorporates environmental uncertainty, information system strategy, and supply chain strategy was proposed in this study. Consequently, the
following hypothesis is proposed:

**Hypothesis 1 (H1): The co-alignment of SC strategy, IS strategy, and environmental uncertainty is positively associated with SCM performance.**

![Diagram](attachment://image.png)

**Figure 1 Co-alignment model of SC strategy, IS strategy and environmental uncertainty**

### 4. METHODOLOGY

Survey method was used to collect the data. A structural equation modeling (SEM) was used to assess the structural model of research model in this study by using EQS technique (Bentler, 1995). The unit of analysis of this study was the manufacturing firm within a SC.

#### 4.1 Measurement Development

Scales to measure each of the constructs in the model were developed either by adopting measures that had been validated by other researchers or by converting the definitions of constructs from the previous literature into a questionnaire format. Specifically, the items for the five attributes of SC strategy — price, flexibility, quality, delivery, and service — were revised from Frohlich and Dixon’s (2001) research, and the items for the four attributes of IS strategy — operational support systems, market...
information systems, interorganizational systems, and strategic decision support systems — were applied directly from Sabherwal and Chan (2001). Furthermore, two dimensions of environmental uncertainties (demand and supply uncertainty) were measured by adapting previously developed items (Premkumar et al. 2005; Li and Lin, 2006). Finally, the items for the dependent variable, SCM performance — customer, internal business process, innovation and learning, and financial — were adapted from Brewer and Speh’s (2000) framework. The questionnaire items for variable attributes were measured using a seven-point Likert scale that ranged from 1 = strongly disagree to 7 = strongly agree. A pretest of the questionnaire was performed by six experts in the SCM and IS areas to ensure content validity and reliability within the target context.

4.2 Sample and Data Collection
This study attempted to empirically examine the SCM performance implications of alignment from manufacturers’ standpoint. Therefore, the sample was limited to manufacturing industries within a SC, and those manufacturing companies place much more emphasis on SCM performance. Data collection was based on a mail questionnaire survey. A systematic approach was followed by this study in constructing the mailing list for the survey. A total of 838 manufacturing firms were selected and contacted from the 1000 leading manufacturing enterprises in Taiwan during 2005. The survey was carried out in late 2006. A total of 330 survey questionnaires were distributed to those companies willing to fill them in, of which 276 questionnaires were returned. The gross response rate was 32.9%. A total of 33 questionnaires were dropped from the final dataset for various reasons. The final dataset thus yielded 243 usable cases, for an effective response rate of 29.0%.

No significant differences were found for the firm size (F=0.332, t=0.938, p=0.565 > 0.05), employee number (F=0.664, t= -0.186, p=0.416 > 0.05), or industry type (χ² =1.829, df = 3, p=0.609 > 0.05) between early and late respondents, indicating that nonresponse bias should not be a major concern in this study.

4.3 Reliability and Validity of Research Constructs
Confirmatory factor analysis (CFA) was performed to determine the measurement reliability and validity in terms of composite reliability, convergent validity, and discriminant validity in this study. Composite reliabilities of all factors exceeded 0.84, well above the required minimum of 0.60 (Bagozzi and Yi, 1988), and also above the 0.70 acceptable threshold, indicating the existence of internal consistence.

In this study, the results of convergent validity testing indicate that all indicator items load on the theorized constructs, and the t-test of all the loadings suggests they are
significant (p < 0.001), which provides evidence of convergent validity (Bagozzi and Yi, 1988). Moreover, each indicator had a higher loading on constructs it was intended to measure than on other constructs. The results suggested sufficient convergent validity to allow an interpretation of structural parameters. This study considered both loadings and cross-loadings for evaluating discriminant validity using confirmatory factor analysis. The square roots of AVEs in this study range from 0.800 to 1.000 and exceed the inter-construct correlations; hence the test of discriminant validity was acceptable. The results of this study suggested sufficient convergent and discriminant validity to allow an interpretation of construct validity.

5. MODEL ASSESSMENT AND RESULTS

5.1 Assessment of the Co-alignment Model
A SEM using an EQS program was deployed to estimate the structural model. According to the arguments proposed by Venkatraman (1989), this study adopted a covariation perspective of alignment and entailed specifying co-alignment as a second-order factor, with the first-order factors reflecting the fit or internal consistency among SC strategy, IS strategy and environmental uncertainty. The results of the co-alignment model are shown in Figure 2. Hypothetically linked to co-alignment, SCM performance is reflected in terms of customer, internal business process, innovation and learning, and financial perspective. Values of 3.5 for the normed $\chi^2$, 0.90 for the CFI, 0.09 for the SRMR and 0.10 for the RMSEA indicated adequate overall fit with no evidence of model overfitting, and provided support for the unidimensionality of the co-alignment and SCM performance measurements as linked within the theoretical network hypothesized in this study.

5.2 Assessment of the Direct Effects Model
As proposed in this study, the first-order constructs of SC strategy, IS strategy and
environmental uncertainty should be consistent and mutually dependent in their effect on SCM performance. This covariation model was an alternative to the direct effects model in which the first-order constructs are assumed not to covary and have a direct causal influence on performance (Venkatraman, 1989). In this way, a direct effects model (i.e., first-order factor model) should compete against the covariation model (second-order factor model).

Using the same data, an estimation of the direct effects model with EQS yielded value of 5.0 for the normed $\chi^2$ ($\chi^2 = 445.6, \text{df} = 90$), 0.841 for CFI, 0.23 for SRMR, 0.13 for RMSEA and 0.58 for $R^2$, as shown in Figure 3.

5.3 Results

The comparison of results showed in Figure 3 with those presented in Figure 2 illustrated the direct effects model to explain 30% less variance in SCM performance ($R^2=0.58$ vs. 0.88), and to show less fit as demonstrated by comparing the fit indices (CFI=0.841 vs. 0.900, SRMR=0.23 vs. 0.09, RMSEA=0.13 vs. 0.10), suggesting that this model is to be rejected in favor of the more parsimonious covariation model. As shown in Figure 2, the basic research proposition of the co-alignment model on the SCM performance effects of co-alignment was confirmed by the positive and highly significant path coefficient ($\gamma = 0.94, p < 0.001$) linking the co-alignment of SC strategy, IS strategy and environmental uncertainty to SCM performance. SCM performance was explained by the co-alignment of SC strategy, IS strategy and environmental uncertainty at a significant amount of the variation ($R^2 = 0.88$), thus providing empirical validation for both the theoretical and methodological foundations of the research model. This implied that a higher level of SCM performance is probable to be achieved when firms are likely toward a co-alignment of SC strategy, IS strategy and environmental uncertainty. Moreover, the result of chi-square test ($\chi^2 = 132.9, \text{df} = 1, p < 0.001$) showed a significant difference between co-alignment and direct effects models of SCM performance. Therefore, the hypothesis 1 (H1) concerning the impact of co-alignment between SC strategy, IS
strategy and environmental uncertainty on SCM performance was supported.

6. DISCUSSION AND CONCLUSION
The purpose of this study was to examine a theoretical model to identify the research question: Are firms that have a good co-alignment of SC strategies, IS strategies and environmental uncertainties better SCM performers? This study confirmed the co-alignment impact on the SCM performance through the result of a highly significant and positive path coefficient ($\gamma = 0.94$, $p < 0.001$) linking the co-alignment of SC strategy, IS strategy and environmental uncertainty to SCM performance. Moreover, the co-alignment model of SC strategy, IS strategy and environmental uncertainty explained 30% more variance in SCM performance than the direct effects model ($R^2 = 0.88$ vs. 0.58) which regards SC strategy, IS strategy and environmental uncertainty as mutually independent constructs, thus providing empirical validation for the co-alignment model. This finding was similar to the study of Li and Ye (1999) with relation to the strategic alignment of business strategy, IS strategy and environmental uncertainty, providing the further evidence to believe that a higher level of SCM performance was fulfilled when firms were likely toward a co-alignment of SC strategy, IS strategy and environmental uncertainty within a SC. The results provided several implications and contributions for research and practice. First, the co-alignment of SC strategy, IS strategy and environmental uncertainty, and its positive effect with SCM performance in this study empirically supported the notion of a contingency effect in SCM area. This finding provided strong evidence for the need of the strategic alignment perspective in improving SCM performance in future research. Second, previous studies have encouraged researchers to examine the performance impacts of strategic alignment not only through a bivariate perspective but also through a multivariate perspective (Venkatraman, 1990). The result of this study supported that the covariation perspective used to manipulate the environment-strategy alignment concept seems highly promising in its capacity to identify and explain the SCM performance impacts of co-alignment among SC strategy, IS strategy and environmental uncertainty, and was in line with Li and Ye (1999) in IS area. Third, for practitioners, the results suggested that the co-alignment approach thus exceeds both strategic integration (i.e., bivariate alignment between SC strategy and IS strategy) and environmental integration (i.e., bivariate alignment between environmental uncertainty and SC strategy or IS strategy) to achieve SCM integration and improve SCM performance. From a contingency perspective, this study applied the covariation approach of alignment to examine the effect of co-alignment among SC strategy, IS strategy and environmental uncertainty on SCM performance. It enables its ability to retain the
The complex and interrelated nature of the relationships among environmental uncertainty, SC strategy and IS strategy rather than looking at the direct causal influence on SCM performance (i.e., using a direct effects approach). The result of this study empirically showed the effect of co-alignment among SC strategy, IS strategy and environmental uncertainty on SCM performance. This study was one of the few to examine the argument that SCM performance can be influenced by aligning SC strategy, IS strategy and environmental uncertainty. In summary, the results of this study offered some valuable implications for SCM practitioners as well as contribute to theory building in SCM area.

REFERENCES


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