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The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance

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ABSTRACT

This paper extends prior supply chain research by building and empirically testing a theoretical model of the contingency effects of environmental uncertainty (EU) on the relationships between three dimensions of supply chain integration and four dimensions of operational performance. Based on the contingency and organizational information processing theories, we argue that under a high EU, the associations between supplier/customer integration, and delivery and flexibility performance, and those between internal integration, and product quality and production cost, will be strengthened. These theoretical propositions are largely confirmed by multi-group and structural path analyses of survey responses collected from 151 of Thailand's automotive manufacturing plants. This paper contributes to operations management contingency research and provides theory-driven and empirically proven explanations for managers to differentiate the effects of internal and external integration efforts under different environmental conditions.

1. Introduction

Growing evidence suggests that supply chain integration (SCI) has a positive impact on operational performance outcomes, such as delivery, quality, flexibility and cost (Rosenzweig et al., 2003; Dröge et al., 2004; Devaraj et al., 2007; Swink et al., 2007; Flynn et al., 2010). Sousa and Voss (2008) suggested that when the value of a best practice, such as SCI, is supported by empirical evidence, research should shift from the justification of its value to the understanding of the contextual conditions under which it is effective. Among other factors, environmental uncertainty (EU) has been identified as a contextual factor which may affect the effectiveness of a best practice (Thompson, 1967; Venkatraman, 1989; Souder et al., 1998).

Some recent studies argue that SCI–performance relationships are moderated by EU (O'Leary-Kelly and Flores, 2002; Fynes et al., 2004; Koufteros et al., 2005). However, these studies are problematic in three areas. First, the use of different approaches in conceptualizing SCI, performance and EU constructs disallows a meaningful comparison of, or conclusion about, the contingency effects of EU. Second, the evidence reported so far indicates that SCI–performance relationships are not always moderated by EU (Fynes et al., 2004; Koufteros et al., 2005), and even if moderating effects exist, their direction varies (O'Leary-Kelly and Flores, 2002). For example, Koufteros et al. (2005) found insignificant moderating effects of EU on the relationships between supplier/customer integration and quality/product innovation. O'Leary-Kelly and Flores (2002) found positive relationships between marketing/sales planning decision integration and firm performance under a high, but not a low EU. However, their results surprisingly indicated that the relationships between manufacturing planning decision integration and firm performance are positive under a low, instead of a high EU. Anchored in the premise that EU creates the need for SCI, some studies argue that SCI–performance relationships will become significant or stronger under a high EU. Such a "theory" cannot explain the above mixed findings. The lack of a theoretical explanation is the third, and perhaps the most pressing issue that deserves more research attention.

This paper builds and empirically tests a theoretical model to explain the contingency effects of EU on the salient operational performance outcomes of SCI. This paper differs from others in a number of aspects. We conceptualize both SCI and operational performance as multidimensional constructs, instead of the unidimensional approach applied by others (e.g., Stank et al., 1999; Rosenzweig et al., 2003). We have collapsed SCI into three dimensions – internal, supplier, and customer integration – to enable the examination of the performance impacts of different SCI dimen-

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sions and to prove that each SCI dimension might be effective under different environmental conditions (Wong and Boon-itt, 2008). Furthermore, we examine four areas of operational performance – delivery, production cost, product quality, and production flexibility – which reflect the four key capabilities of a focal firm in responding to competition (Schmenner and Swink, 1998). The consideration of multiple performance dimensions not only helps to explain the mixed findings in the literature, but also addresses the need to obtain a holistic understanding of the relationships among contingencies (in this case, EU), response alternatives (different dimensions of SCI) and multiple performance criteria (Sousa and Voss, 2008).

Most importantly, we have integrated the contingency theory (CT) and organizational information processing theory (OIPT) to explain the contingency effects of EU. CT posits that firm performance is dependent on the "fit" between the structure and processes of a firm, and the environment (Lawrence and Lorsch, 1967; Thompson, 1967; Miller, 1987). Based on CT, external integration is expected to "fit" with a high EU (Thompson, 1967). The OIPT further provides the conceptual foundation upon which such a "fit" is valuable for firms to achieve a certain performance. The OIPT suggests the need to improve information processing capability and information quality under high uncertainty (Galbraith, 1973). The OIPT also recognizes that, as an open social–economical system, a firm performs business processes within and beyond organizational boundaries (Thompson, 1967), which suggests the need to distinguish internal from external integration. Based on the OIPT, we expect that firms need external integration to improve information processing capability, especially to cope with a high EU. Specifically, we argue that delivery and production flexibility are highly sensitive to uncertainty from the external environment and therefore, can be improved by external integration, but not internal integration, under a high EU. On the other hand, product quality and production cost are more internally dependent (Ragatz et al., 2002) and therefore, unlike external integration (Dröge et al., 2004), the impacts of internal integration on product quality and production cost will be strengthened under a high EU. Based on a survey of Thailand's automotive supply chains, our findings largely support our contingency arguments.

The novel theories and results of this paper offer numerous implications to the operations and supply chain management research on SCI. First, this paper supplements previous studies by providing theories and supporting evidence to explain why the performance impacts of some SCI dimensions could be strengthened or weakened, and thus, contributes to operations management contingency research (Sousa and Voss, 2008). This novel understanding is very important for both researchers and managers. Such an explanation of the contingency effects of EU not only clarifies the tenuous relationships between SCI, operational performance and EU (Stonebraker and Liao, 2006), but also contributes to the building of a contingency theory for SCI. Furthermore, this paper provides theory-driven and empirically proven explanations for managers to differentiate the effects of internal and external integration efforts on various operational performance outcomes under different environmental conditions. Since integration efforts involve costs (Souder et al., 1998; O'Leary-Kelly and Flores, 2002) and risks (Fabbe-Costes and Jahre, 2008), it is important to inform managers precisely which SCI efforts are effective under specific environmental conditions.

2. Theoretical model and hypotheses

In this section, we first define the key theoretical constructs and then develop a theoretical model and hypotheses to explain the moderating effects of EU on SCI–performance relationships.

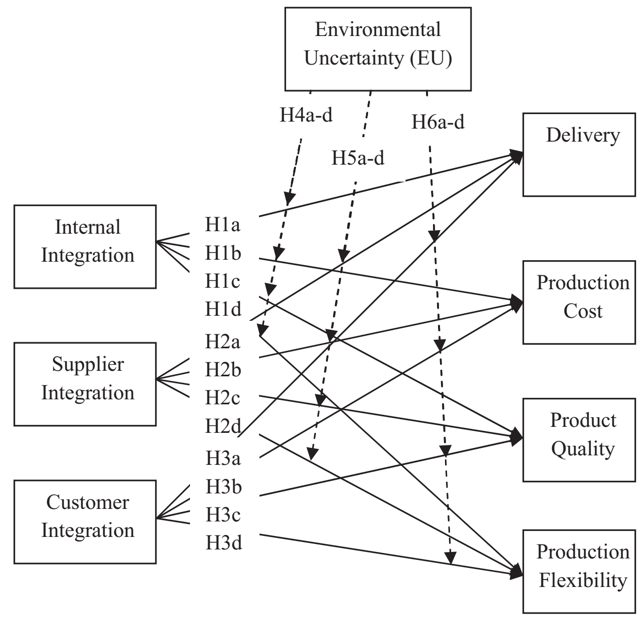

Fig. 1. Theoretical model.

2.1. Dimensions of supply chain integration (SCI)

The understanding of SCI requires clear construct definitions and good measures (Fabbe-Costes and Jahre, 2008; Flynn et al., 2010). Following Pagell (2004) and Flynn et al. (2010), SCI is defined as the strategic collaboration of both intra-organizational and inter-organizational processes. We have collapsed SCI construct into three dimensions: customer, supplier and internal integration, to reflect its multidimensionality (Flynn et al., 2010). In this paper, internal integration is defined as the strategic system of cross-functioning and collective responsibility across functions (Follett, 1993), where collaboration across product design, procurement, production, sales and distribution functions takes place to meet customer requirements at a low total system cost (Morash et al., 1997). Internal integration efforts break down functional barriers and facilitate sharing of real-time information across key functions (Wong et al., 2007).

External integration comprises supplier and customer integration. Supplier integration involves strategic joint collaboration between a focal firm and its suppliers in managing cross-firm business processes, including information sharing, strategic partnership, collaboration in planning, joint product development, and so forth (Ettlie and Reza, 1992; Lai et al., 2010; Ragatz et al., 2002). Likewise, customer integration involves strategic information sharing and collaboration between a focal firm and its customers which aim to improve visibility and enable joint planning (Fisher et al., 1994). Customer integration enables a deeper understanding of market expectations and opportunities, which contributes to a more accurate and quicker response to customer needs and requirements (Swink et al., 2007) by matching supply with demand (Lee et al., 1997). The above definitions are distinct from those in some of the existing literature which ignore the differences between the dimensions of integration (Stank et al., 1999; Rosenzweig et al., 2003).

2.2. The SCI–performance relationships

Fig. 1 illustrates our proposed theoretical model which suggests the impacts of the three SCI dimensions on four operational performance outcomes under the effects of EU. A model is proposed for each SCI dimension because we intend to clarify the distinct impacts of each SCI dimension under varying EUs.

We first examine the relationships between internal, supplier and customer integration and the four dimensions of operational performance without taking into consideration the effects of EU. To understand internal integration–performance relationships, we draw upon existing knowledge from total quality management (TQM), product development, and production literature. Internal integration is arguably the basis of SCI; it removes functional barriers (Flynn et al., 2010) and enables cooperation across internal functions (Morash et al., 1997). As suggested by the TQM literature, the successful implementation of quality management requires a constancy of purpose and breaking down of barriers between departments (Deming, 1982). With a lack of internal integration, different functions may work at cross-purposes and result in effort redundancy and waste of resources, which can have a detrimental impact on cost and quality performance (Pagell, 2004). Likewise, the product development literature ascertains that internal integration enables product design, engineering, manufacturing, and marketing departments to work closely in supporting concurrent engineering and design for manufacturing (Crawford, 1992). Internal integration facilitates cross functional teams to simultaneously improve product and process designs, which are instrumental to reducing production cost (Ettlie and Stoll, 1990) and improving product quality (Rosenzweig et al., 2003). From the production literature, there are arguments that internal integration enables the sharing of knowledge across functions and manufacturing plants (Roth, 1996; Narasimhan and Kim, 2002), and allows for better coordination of production capacity to improve production flexibility (Sawhney, 2006) and delivery performance (Dröge et al., 2004). These theoretical arguments have been supported by numerous studies which demonstrated positive associations between internal integration and process efficiency (Saeed et al., 2005; Swink et al., 2007), logistics service performance (Germain and Iyer, 2006; Stank et al., 2001), delivery performance (Swink et al., 2007), quality (Swink et al., 2007) and product development cycle time or responsiveness (Dröge et al., 2004). All these theoretical arguments and empirical evidence suggest the following hypothesis.

Hypothesis 1. Internal integration is positively associated with (a) delivery, (b) production cost, (c) product quality, and (d) production flexibility.

Employing a reductionist approach, we view a focal firm as an internal environment and suppliers and customers as its external environment. We argue that such an approach allows us to understand how each SCI dimension operates, as well as how its performance impacts may be affected by EU. Within a focal firm, new product development, marketing, procurement, production and logistics are major tasks that contribute to operational performance improvement. However, the performance of these tasks greatly depends on input and collaboration from suppliers and customers. Based on the OIPT developed by Galbraith (1973), external integration supports external routines and processes that collect accurate demand and supply information essential for the coordination of the above tasks (Stank et al., 1999). With a low level of supplier and customer integration, a focal firm is more likely to receive inaccurate or distorted supply and demand information, which results in poor production plans, high level of inventory and poor delivery reliability (Lee et al., 1997).

Furthermore, integration with suppliers and customers promotes cooperation and development of cross-firm problem-solving routines (Flynn and Flynn, 1999; Narasimhan and Jayaram, 1998). This creates mutual understanding and facilitates task coordination, which help to reduce wastage and redundancy of efforts in managing supply chain activities across partner firms (Swink et al., 2007). More importantly, integration with customers and suppliers helps to resolve conflicting objectives and further facilitates joint efforts in cost and inventory reduction, quality improvement and new product development, which result in a better time-based performance, such as delivery and production flexibility (Scannell et al., 2000; Rosenzweig et al., 2003), and product quality (Scannell et al., 2000; Ettlie and Reza, 1992; Rosenzweig et al., 2003). Furthermore, external integration improves process flexibility (Ettlie and Reza, 1992) by allowing supply chain partners to better anticipate and coordinate supply and demand (Flynn et al., 2010). Such a coordination effort is essential for the improvement of delivery performance as well as a quick response to changing market needs. Furthermore, prior studies have ascertained positive associations between supplier integration and cost (Scannell et al., 2000; Devaraj et al., 2007), supply chain integration intensity and product quality and delivery reliability (Rosenzweig et al., 2003), and external integration and time-based performance (Dröge et al., 2004). All these theoretical arguments and empirical evidence suggest the following hypotheses.

Hypothesis 2. Supplier integration is positively associated with (a) delivery, (b) production cost, (c) product quality, and (d) production flexibility.

Hypothesis 3. Customer integration is positively associated with (a) delivery, (b) production cost, (c) product quality, and (d) production flexibility.

2.3. The strengths of SCI–performance relationships under EU

Uncertainty can be defined as the inability to assign probabilities to future events (Duncan, 1972) or the difficulties to accurately predict the outcomes of decisions (Downey et al., 1975; Duncan, 1972). In this paper, we focus on the uncertainty aroused from the external environment of a focal firm and therefore, call it environmental uncertainty (EU). In the context of a supply chain, EU is an inherent condition of cross-firm interactions because the flow of goods and information involve multiple lines of communication and tasks across firms (Miller, 1987), making it difficult to predict the causal relationships of events. In this paper, EU is considered as a moderator of SCI–performance relationships. Our main focus is the strength but not the form of the moderation effect (Venkatraman, 1989). This means we aim to investigate the impact of EU on the strengths of SCI–performance relationships, but not the joint effect of SCI dimensions and EU on performance outcomes.

To explain the moderating effects of EU, we have integrated CT with OIPT. According to the CT, a firm's performance is attributable to the "match" or "fit" between its structure and processes with environmental conditions (Lawrence and Lorsch, 1967; Thompson, 1967; Miller, 1987). The CT suggests that firms often enact or shape their business environment through a series of externally oriented strategies when facing uncertainty in their environment (Thompson, 1967). The CT posits that external integration is expected to "fit" with a high EU (Thompson, 1967). Furthermore, the OIPT suggests the need to improve information processing capability and information quality under high uncertainty (Galbraith, 1973; Thompson, 1967). There is certainly a need to acquire and process additional and rich information under a high EU (Stonebraker and Liao, 2006; Koufteros et al., 2005) because a high EU creates the need to scan the markets. Consequently, this would then require external integrative mechanisms to collect information (Galbraith, 1973), coordinate and monitor business activities of partner firms (Miller, 1992), and facilitate flexible response and quick decision-making (Sitkin et al., 1994). These two theories strongly suggest the need to distinguish internal from external integration, which was previously suggested by Miller (1992).

To further explain the direction of moderating effects, we distinguish the mechanisms in which internal and external integration affect different groups of operational performance outcomes. A study by Souder et al. (1998) concluded that different integration dimensions will have different impacts on different performance measures. We argue that time-based performance outcomes, such as delivery and production flexibility, are highly sensitive to external inputs, such as the accuracy and timeliness of supply and demand information (Blackburn, 1991). Thus, under a high EU, supplier and customer integration are likely to strengthen delivery and production flexibility performance. Furthermore, for manufacturers operating in a just-in-time (JIT) production environment, internal integration alone may not be adequate for improving delivery performance and production flexibility, especially when there are high levels of demand and supply uncertainties (Schonberger, 1986), where a firm needs to acquire market information in addition to coordinate its internal functions. Thus, we posit that, under a high EU, the associations between internal integration and delivery performance and production flexibility will not be strengthened, but those between supplier and customer integration, and delivery performance and production flexibility, will be strengthened.

On the other hand, product quality and production cost performance of a focal firm heavily relies on internal fit and constancy of purpose across functions. According to the TQM literature, it is the sharing of information, constancy of purpose and cooperation across functions which allow workers to focus on cost reduction and quality improvement (Deming, 1982; Crawford, 1992). Under a high EU, cross-functional integration will further enable the exploration and synergy of cross-functional knowledge sharing (Roth, 1996) and therefore, helps to develop new skills and resources to improve product quality and cost (Sitkin et al., 1994). Thus, we argue that the associations between internal integration, and product quality and production cost will be strengthened under a high EU. A high EU will also create the need for external alignment with suppliers and customers, but not necessarily improve product quality and production cost. In fact, the literature on product development argues that the performance impact of supplier integration diminishes under EU. Eisenhardt and Tabrizi (1995) revealed that supplier integration has a negative impact, particularly in uncertain environments, as supplier and customer collaboration makes product development more costly, complicated, time-consuming, and difficult to manage and control. Furthermore, in the context of an automotive supply chain, product quality is often regarded as an order qualifier for supplier qualification purpose. Thus, product quality is not the main focus of supplier and customer integrative efforts, and we do not expect the external integration–product quality relationships to be strengthened under a high EU. With the above arguments, we have established the following three hypotheses.

Hypothesis 4. Under a high EU, the associations between internal integration and (b) production cost and (c) product quality will be strengthened, but those between internal integration and (a) delivery and (d) production flexibility, will not be strengthened.

Hypothesis 5. Under a high EU, the associations between supplier integration and (a) delivery and (d) production flexibility will be strengthened, but those between supplier integration (b) production cost and (c) product quality, will be not strengthened.

Hypothesis 6. Under a high EU, the associations between customer integration and (a) delivery and (d) production flexibility will be strengthened, but those between customer integration and (b) production cost and (c) product quality, will be not strengthened.

3. Research method

3.1. Sample and data collection

This study focuses on Thailand's automotive industry, which is one of the largest motor vehicle manufacturing bases in terms of gross output and export value in the world currently ranking 13th globally. According to the Federation of Thai Industries, Thailand produced approximately 1.7 million motor vehicles in 2010, which accounted for 10.5 percent of the Thai economy (The Economist Intelligence Unit, 2010). Compared to 325,000 units produced in 2000, Thailand has the highest production growth rate among the major Association of Southeast Asian Nations (ASEAN) motor vehicle producing countries (Wad, 2009). Furthermore, Thailand's automotive industry exports half of the vehicles produced worth about 250 million U.S. dollars. Thailand is poised to become an export-oriented auto producing country with exports far surpassing domestic use (Janakiraman, 2010). Many foreign major automakers, including Toyota, Mitsubishi, General Motors, Nissan, Honda, and Ford, set up their production facilities and operations in Thailand (Fuller, 2010b) to seize the advantage of low exchange rate and labor costs (Tabuchi, 2010), and financing supports of local banks (Fuller, 2010a).

We tested our theoretical model through a survey of Thailand's automotive industry for four main reasons. First, automotive supply chains and operational structures have been well documented in previous research, and SCI is widely adopted in the industry (Lockström et al., 2010). Secondly, the automotive sector is a leading Thai industry in implementing SCI strategies (Pantumsinchai, 2002). Thirdly, focusing on a single industry will ensure high internal validity. Finally, previous studies on the contingency effects of EU were conducted based largely on samples from developed countries such as the U.S.; studies in developing countries such as Thailand will allow us to assess the validity of the contingency arguments.

The sample for this research was identified from two sources: (1) the Directory of the Society of Automotive Engineering of Thailand, and (2) the Thailand Automotive Industry Directory. A mailing list of 799 automakers and first-tier automotive suppliers in Thailand was established. Sample selection is not an issue because the mailing list covered the whole population. An address validation exercise was conducted, which resulted in a final mailing list of 724 firms. Positions, such as CEO/president, vice president/director, operations manager, and supply chain manager, were identified as respondents because of their knowledge on the level of SCI practices and operational performance in their firms.

We followed Frohlich's (2002) suggestion to improve the response rate by calling all 724 respondents before sending out the questionnaire. The questionnaire was then sent out in two phases. In the first phase, 116 responses were received. Phone calls were then made to targeted respondents who did not respond, and consequently, we received 47 additional responses in the second phase. Twelve returned questionnaires were discarded due to incomplete responses, which resulted in 151 usable responses. A response rate of 20.85% is close to the recommended number for empirical studies in operations management (Malhotra and Grover, 1998). Table 1 summarizes the demographic characteristics of the respondents. Of the respondents, 12% are automakers, and the rest are different part suppliers.

Non-response bias was first tested by using the extrapolation method suggested by Armstrong and Overton (1977). A comparison between early and late responses showed no statistical differences across the 4 key characteristics and 10 measures at $p < 0.05$, which suggests no non-response bias. We further tested non-response bias by conducting a t-test to check whether there is any significant difference across 4 key characteristics and 10 measures between

Table 1
Demographic characteristics of respondents.

Demographic characteristics	Percentage of samples (%)
Position of respondents	
Supply chain manager	40
Purchasing/logistics manager	22
General manager	22
Production manager	8
President/managing director	8
Ownership	
100% Thai owned	48
Thai-foreign joint ventures	34
Foreign owned	18
Number of employees	
>700	16
351–250	23
201–250	23
101–200	18
51–100	16
<50	4

early respondents and respondents who initially declined to participate, but later returned the questionnaires. The *t*-test results show no significant difference ($p < 0.05$), which suggests no non-response bias issues.

Since data were collected from a single person at a single point in time, common method variance (CMV) might be a threat to the validity of our results. Thus, we segmented the questions that pertained to the independent (SCI) and dependent (operational performance) variables into different sections in the questionnaire (Podsakoff et al., 2003). We conducted the Harman's one-factor test (Podsakoff and Organ, 1986) to ensure that no one general factor accounted for the majority of covariance between the predictor and criterion variables. Our factor analysis indicated no single factor, where the independent and dependent variables load on different factors with the first factor accounting for less than 40% of total variance, which suggests that there is no CMV problem.

3.2. Measures and questionnaire design

As depicted in Table 2, all measures of our key constructs are adapted from the literature. We adapted existing scales to measure internal integration (Stank et al., 2001; Narasimhan and Kim, 2002; Flynn et al., 2010), supplier and customer integration (Narasimhan and Kim, 2002; Flynn et al., 2010), delivery, product quality and production cost (Ward and Duray, 2000; Boyer and Lewis, 2002), and production flexibility (Gupta and Somers, 1992; Chang et al., 2003). EU is conceptualized as a composite measure of supply, demand, competitive, and technological uncertainties based on the scales developed by Germain et al. (1994) and Wong et al. (2009). A five-point Likert scale was used for all the above constructs; a higher value indicates a higher level of integration and uncertainty, or a better performance.

Since the scales adapted from the literature were in English, they were translated into Thai by two bilingual Thai researchers. A back-translation process was applied to ensure conceptual equivalence (Cai et al., 2010). Three academics from the field of supply chain and operations management reviewed the initial measurement scales and provided feedback. Next, we invited four expert judges who have related industry experience to validate the scales using the Q-Sort method. The Q-Sort method required experts to sort the scales into groups, in which each group corresponded to a construct upon agreement (Moore and Benbasat, 1991). The Q-Sort results suggested acceptable content validity because the scale achieved a placement score greater than 70% (Moore and Benbasat, 1991). As suggested by Hensley (1999), the revised questionnaire was pilot-tested with a small-scale survey (21 potential respondents) to ensure that the indicators were understandable and relevant to practices in Thailand's automotive industry. Feedback from the pilot test was used to improve the wording in some of the questions.

3.3. Measure validation and reliability

The unidimensionality of the key constructs were assessed by a confirmatory factor analysis (CFA). The CFA results summarized in Table 2 show that the comparative fit index (CFI) values and the standardized root mean square residual (SRMR) values are well above the recommended cut-off value of 0.90, and below or equal the recommended value of 0.08, respectively (Hu and Bentler, 1999), which suggest all the constructs are unidimensional. Furthermore, the incremental fit index (IFI) and the Tucker-Lewis index (TLI) are also well above the recommended threshold of 0.90 (Hu and Bentler, 1999).

The reliability of the constructs and scales was assessed using Cronbach's alpha and composite reliability. As shown in Table 2, the Cronbach's alpha and composite reliability of all the constructs are greater than 0.70, which indicate adequate reliability of the measurement scales (Nunnally, 1978; Fornell and Larcker, 1981; O'Leary-Kelly and Vokurka, 1998). Following O'Leary-Kelly and Vokurka's (1998) suggestion, we evaluated the convergent validity of each measurement scale by conducting another CFA using the maximum likelihood approach. As summarized in Table 2, all indicators in their respective constructs have statistically significant ($p < 0.05$) factor loadings from 0.50 to 0.90, which suggest convergent validity of the theoretical constructs (Anderson and Gerbing, 1988). Furthermore, the average variance extracted (AVE) of each construct exceeds the recommended minimum value of 0.5 (Fornell and Larcker, 1981), which indicates strong convergent validity.

Table 3 presents the means, standard deviations, and correlations of all the theoretical constructs. The bivariate correlations between the SCI and operational performance outcomes range from 0.33 to 0.46 with significances $p < 0.01$, which indicate acceptable criterion validity (Nunnally, 1978). The possibility of multicollinearity among the indicators is assessed by computing the variance inflation factor (VIF), which evaluates the degree to which each variable can be explained by other variables (Hair *et al.*, 1998). All VIFs are well below the maximum acceptable cut-off value of 10, which indicate the absence of multicollinearity (Neter et al., 1996).

The discriminant validity of the constructs is tested by measuring the degree to which each construct and its indicators are different from another construct and its indicators. We conducted a series of χ^2 difference tests between nested CFA models for all pairs of constructs. For each pair of constructs, we compared the χ^2 between the unconstrained model (with two constructs varying freely) and the constrained model (with the correlations between two constructs constrained to 1) (Bagozzi et al., 1991). Table 4 summarizes the χ^2 for the unconstrained and constrained models. Significant χ^2 differences between all pairs of constructs suggest discriminant validity (Bagozzi et al., 1991). In addition, the square root of AVE of all the constructs is greater than the correlation between any pair of them as shown in Table 3, which indicates a satisfactory level of discriminant validity (Fornell and Larcker, 1981).

4. Analyses and results

4.1. SCI–performance relationships

We first established a structural equation model to test each hypothesis (H), H1–H3. According to the results summarized in

Table 2
Construct reliability and validity analysis.

Construct (source)/indicator	Loading	Reliability and validity
Internal integration (Stank et al., 2001; Narasimhan and Kim, 2002; Flynn et al., 2010)		
Have a high level of responsiveness within our plant to meet other department's needs	0.74	Goodness-of-fit indices: χ^2 = 11.67, df = 2, p < 0.001; CFI = 0.96; IFI = 0.96; TLI = 0.90; SRMR = 0.03; Cronbach's alpha = 0.83; composite reliability = 0.83; AVE = 0.56
Have an integrated system across functional areas under plant control	0.83	
Within our plant, we emphasize on information flows among purchasing, inventory management, sales, and distribution departments	0.67	
Within our plant, we emphasize on physical flows among production, packing, warehousing, and transportation departments	0.72	
Supplier integration (Narasimhan and Kim, 2002; Flynn et al., 2010)		
Share information to our major suppliers through information technologies	0.72	Goodness-of-fit indices: χ^2 = 8.01, df = 4, p < 0.001; CFI = 0.98; IFI = 0.98; TLI = 0.96; SRMR = 0.03; Cronbach's alpha = 0.79; composite reliability = 0.87, AVE = 0.51
Have a high degree of strategic partnership with suppliers	0.88	
Have a high degree of joint planning to obtain rapid response ordering process (inbound) with suppliers	0.80	
Our suppliers provide information to us in the production and procurement processes	0.53	
Our suppliers are involved in our product development processes	0.80	
Customer integration (Narasimhan and Kim, 2002; Flynn et al., 2010)		
Have a high level of information sharing with major customers about market information	0.70	Goodness-of-fit indices: χ^2 = 9.09, df = 2.27, p < 0.001; CFI = 0.99; IFI = 0.98; TLI = 0.94; SRMR = 0.04; Cronbach's alpha = 0.79; composite reliability = 0.86; AVE = 0.50
Share information to major customers through information technologies	0.70	
Have a high degree of joint planning and forecasting with major customers to anticipate demand visibility	0.71	
Our customers provide information to us in the procurement and production processes	0.82	
Our customers are involved in our product development processes	0.79	
Delivery (Ward and Duray, 2000; Boyer and Lewis, 2002)		
Correct quantity with the right kind of products	0.76	Goodness-of-fit indices: χ^2 = 10.94, df = 5, p < 0.001; CFI = 0.99; IFI = 0.99; TLI = 0.99; SRMR = 0.02; Cronbach's alpha = 0.90; composite reliability = 0.90; AVE = 0.64
Delivery products quickly or short lead-time	0.87	
Provide on-time delivery to our customers	0.90	
Provide reliable delivery to our customers	0.84	
Reduce customer order taking time	0.70	
Production cost (Ward and Duray, 2000; Boyer and Lewis, 2002)		
Produce products with low costs	0.80	Goodness-of-fit indices: χ^2 = 3.26, df = 2, p < 0.001; CFI = 0.99; IFI = 0.99; TLI = 0.99; SRMR = 0.01; Cronbach's alpha = 0.84; composite reliability = 0.85; AVE = 0.58
Produce products with low inventory costs	0.78	
Produce products with low overhead costs	0.86	
Offer price as low or lower than our competitors	0.60	
Product quality (Ward and Duray, 2000; Boyer and Lewis, 2002)		
High performance products that meet customer needs	0.76	Goodness-of-fit indices: χ^2 = 10.10, df = 2, p < 0.001; CFI = 0.92; IFI = 0.92; TLI = 0.90; SRMR = 0.07; Cronbach's alpha = 0.75; composite reliability = 0.76; AVE = 0.50
Produce consistent quality products with low defects	0.78	
Offer high reliable products that meet customer needs	0.86	
High quality products that meet our customer needs	0.60	
Production flexibility (Gupta and Somers, 1992; Chang et al., 2003)		
Able to rapidly change production volume	0.57	Goodness-of-fit indices: χ^2 = 40.08, df = 5, p < 0.001; CFI = 0.92; IFI = 0.92; TLI = 0.90; SRMR = 0.04; Cronbach's alpha = 0.80; composite reliability = 0.80; AVE = 0.51
Produce customized product features	0.68	
Produce broad product specifications within same facility	0.79	
The capability to make rapid product mix changes	0.79	
Environmental uncertainty (Wong et al., 2009; Germain et al., 1994)		
Our customers often change their order over the month	0.80	Goodness-of-fit indices: χ^2 = 6.52, df = 2, p < 0.001; CFI = 0.92; IFI = 0.92; TLI = 0.90; SRMR = 0.06; Cronbach's alpha = 0.70; composite reliability = 0.72, AVE = 0.50
Our suppliers performance is unpredictable	0.54	
Competitors' actions regarding marketing promotions are unpredictable	0.65	
Our plant uses core production technologies that often change	0.80	

Table 3
Mean, standard deviations, and correlations of the constructs.

Variables	Mean	S.D.	II	SI	CI	D	PC	PQ	PF	EU
II	3.75	0.69	.748							
SI	3.67	0.69	.477**	.714						
CI	3.80	0.70	.576**	.614**	.707					
D	3.99	0.68	.444**	.418**	.353**	.800				
PC	3.22	0.66	.341**	.390**	.345**	.427**	.762			
PQ	4.04	0.64	.447**	.465**	.462**	.514**	.448**	.707		
PF	3.72	0.69	.234**	.279**	.332**	.275**	.468**	.382**	.842	
EU	2.94	0.68	–.013	.069	.001	–.217**	–.069	–.063	.246**	.707

Note: Square root of AVE is on the diagonal; II: internal integration; SI: supplier integration; CI: customer integration; D: delivery; PC: production cost; PQ: product quality; PF: production flexibility; EU: environmental uncertainty.

** Correlation is significant at the 0.01 level (two-tailed).

Table 4
Discriminant validity analysis.

Construct pairs	Unconstrained		Constrained		$\Delta\chi^2$
	χ^2	df	χ^2	df	
Internal integration					
Supplier integration	81.69	26	155.60	27	73.91***
Customer integration	81.13	26	123.46	27	42.33***
Production cost	35.73	19	120.30	20	84.57***
Delivery	57.49	26	131.25	27	73.76***
Product quality	30.40	19	100.92	20	70.52***
Production flexibility	51.57	19	137.82	20	86.25***
Environmental uncertainty	37.24	19	123.98	20	86.74***
Supplier integration					
Customer integration	127.55	34	180.72	35	53.17***
Production cost	65.09	26	156.08	27	90.99***
Delivery	84.49	34	177.99	35	93.50***
Product quality	64.01	26	145.79	27	81.78***
Production flexibility	81.79	26	175.46	27	93.67***
Environmental uncertainty	93.74	26	175.47	27	81.73***
Customer integration					
Production cost	57.56	26	127.78	27	70.22***
Delivery	66.54	34	130.36	35	63.82***
Product quality	51.57	26	106.18	27	54.61***
Production flexibility	74.74	26	135.24	27	60.50***
Environmental uncertainty	64.89	26	127.85	27	62.96***
Production Cost					
Delivery	38.25	26	119.18	27	80.93***
Product quality	24.97	19	103.02	20	78.05***
Production flexibility	71.96	19	144.04	20	72.08***
Environmental uncertainty	41.77	19	142.30	20	100.53***
Delivery					
Product quality	54.43	26	124.13	27	69.70***
Production flexibility	65.84	26	152.42	27	86.58***
Environmental uncertainty	47.91	26	165.70	27	117.79***
Product quality					
Production flexibility	37.12	19	114.95	20	77.83***
Environmental uncertainty	34.29	19	135.90	20	101.61***
Production flexibility					
Environmental uncertainty	47.70	19	105.31	20	57.61***

*** $p < 0.001$.

Table 5
Structural model testing.

Structural paths	Standardized estimates	R^2
Internal integration and operational performance		
H1 (a) Internal integration → Delivery	0.68 (5.08)***	0.48
H1 (b) Internal integration → Production cost	0.62 (4.64)***	0.38
H1 (c) Internal integration → Product quality	0.71 (5.11)***	0.50
H1 (d) Internal integration → Production flexibility	0.42 (3.89)***	0.18
Model fit: χ^2 = 342.919, df = 182; CFI = 0.91; IFI = 0.91; TLI = 0.90; SRMR = 0.07		
Supplier integration and operational performance		
H2 (a) Supplier integration → Delivery	0.66 (4.13)***	0.44
H2 (b) Supplier integration → Production cost	0.66 (4.24)***	0.44
H2 (c) Supplier integration → Product quality	0.73 (4.26)***	0.54
H2 (d) Supplier integration → Production flexibility	0.49 (3.18)***	0.24
Model fit: χ^2 = 336.08, df = 203; CFI = 0.92; IFI = 0.92; TLI = 0.91; SRMR = 0.06		
Customer integration and operational performance:		
H3 (a) Customer integration → Delivery	0.61 (4.47)***	0.37
H3 (b) Customer integration → Production cost	0.61 (4.38)***	0.37
H3 (c) Customer integration → Product quality	0.73 (4.87)***	0.53
H3 (d) Customer integration → Production flexibility	0.53 (3.61)***	0.28
Model fit: χ^2 = 350.63, df = 203; CFI = 0.91; IFI = 0.91; TLI = 0.90; SRMR = 0.06		

Numbers in parenthesis are *t*-values.
*** $p < 0.001$.

Table 5, the overall fits of all three structural models are good, with the CFI, IFI, and TLI well above the recommended threshold of 0.90 (Hu and Bentler, 1999), and the SRMR less than 0.08 (Hu and Bentler, 1999).

Table 5 indicates that internal integration is positively and significantly ($p < 0.001$) associated with the four areas of operational performance, which lends support for H1a-H1d. Similarly, supplier integration is positively and significantly ($p < 0.001$) associated with the four areas of operational performance, which provides support for H2a–H2d. Finally, the same holds for customer integration ($p < 0.001$), which lends support for H3a–H3d.

4.2. *Contingency effects of environmental uncertainty (EU)*

To examine the contingency effects of EU on the SCI–performance relationships (H4–H6), we created a two-

Table 6
Results of multi-group analysis.

Models	χ^2	df	χ^2/df	IFI	CFI	RMR	$\Delta\chi^2$	Δdf	χ^2 difference test	High environmental uncertainty ($n = 75$)	Low environmental uncertainty ($n = 76$)	Hypotheses
Panel A: Multi-group analysis for hypothesis H4												
1. Baseline Model	608.16	362	1.68	0.90	0.90	0.06						
2. Constrained Model	690.66	412	1.68	0.86	0.85	0.08	82.50	50	$p < 0.05$			
3. Constrained paths												
3a. Internal integration → delivery	609.25	363	1.68	0.89	0.89	0.08	1.09	1	Insignificant	0.67[a] (3.29)***	0.78 (4.29)***	H4a supported
3b. Internal integration → production cost	612.75	363	1.68	0.90	0.90	0.06	4.59	1	$p < 0.05$	0.72 (3.46)***	0.42 (2.84)**	H4b supported
3c. Internal integration → product quality	612.12	363	1.68	0.90	0.90	0.06	3.96	1	$p < 0.05$	0.76 (3.64)***	0.58 (3.73)***	H4c supported
3d. Internal integration → production flexibility	610.90	363	1.68	0.90	0.90	0.06	1.94	1	Insignificant	0.47(2.87)**	0.33 (2.36)*	H4d supported
Panel B: Multi-group analysis for hypothesis H5												
1. Baseline Model	667.02	404	1.65	0.90	0.90	0.07						
2. Constrained Model	746.21	455	1.64	0.89	0.88	0.08	79.19	51	$p < 0.05$			
3. Constrained paths												
3a. Supplier integration → delivery	670.96	405	1.65	0.90	0.90	0.08	3.94	1	$p < 0.05$	0.72[a] (2.19)*	0.65 (3.22)***	H5a supported
3b. Supplier integration → production cost	669.40	405	1.65	0.89	0.88	0.07	2.38	1	Insignificant	0.68 (2.24)*	0.63 (3.43)***	H5b supported
3c. Supplier integration → product quality	669.54	405	1.65	0.89	0.89	0.07	2.52	1	Insignificant	0.74 (2.21)*	0.73 (3.58)***	H5c supported
3d. Supplier integration → production flexibility	671.57	405	1.66	0.90	0.90	0.08	4.55	1	$p < 0.05$	0.62 (2.04)*	0.40 (2.12)*	H5d supported
Panel C: Multi-group analysis for hypothesis H6												
1. Baseline Model	660.52	400	1.65	0.92	0.90	0.06						
2. Constrained Model	768.68	453	1.70	0.83	0.84	0.08	108.16	53	$p < 0.05$			
3. Constrained paths												
3a. Customer integration → delivery	660.79	401	1.65	0.90	0.89	0.08	0.27	1	Insignificant	0.69 [a] (3.68)***	0.67 (2.54) **	H6a not supported
3b. Customer integration → production cost	660.80	401	1.65	0.89	0.89	0.08	0.28	1	Insignificant	0.66 (3.60)***	0.60 (2.44)***	H6b supported
3c. Customer integration → product quality	660.99	401	1.60	0.89	0.89	0.08	0.47	1	Insignificant	0.78 (4.11)***	0.78 (2.59)**	H6c supported
3d. Customer integration → production flexibility	664.44	627	1.60	0.89	0.89	0.08	3.92	1	$p < 0.05$	0.65 (3.24)***	0.47 (2.00)*	H6d supported

t-Values are in brackets.
[a] Paths coefficients.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

group model by dividing the sample into high ($n = 75$, mean = 3.50) and low ($n = 76$, mean = 2.40) EU groups based on the median of its composite score (Germain et al., 2008). Next, we conducted multi-group and structural path analyses using AMOS 17.0. A multi-group analysis for each dimension of the SCI was conducted to investigate the performance impacts under the influence of high and low EUs. This procedure satisfies the recommended guidelines of having at least a couple of cases per free parameter in each model for each high and low EU group (Marsh et al., 1998). Table 6 summarizes the results of the multi-group and structural path analyses.

Panel A in Table 6 summarizes the path estimates and χ^2 statistics for the path from internal integration to the various operational performance outcomes under high and low EUs (H4). We found significant differences in the χ^2 statistics ($\Delta\chi^2 = 82.50$, $\Delta df = 50$, $p < 0.05$) between the baseline model (e.g., the structural model parameters varied freely across the two uncertainty groups), and the constrained model (e.g., structural parameters constrained to be equal across the two uncertainty groups), which suggest variance of the model under high and low EUs. We then tested the equality of the paths between the high and low EU groups. A significant $\chi 2$ difference ($\Delta\chi^2$ with $p < 0.05$) indicates a moderation effect of the EU. The results showed that the internal integration–delivery relationship is significant but invariant in terms of its strengths under high and low EUs ($\Delta\chi^2 = 1.09$, $p > 0.05$), which lends support for H4a. The results further indicated that the internal integration–production cost relationship is significant under low ($\beta = 0.42$, $p < 0.01$) and high EUs ($\beta = 0.72$, $p < 0.001$). Based on a significant difference in the χ^2 statistics ($\Delta\chi^2 = 4.59$, $p < 0.05$) and the difference in β, we concluded that the internal integration–production cost relationship is strengthened under a high EU, which lends support for H4b. The relationship between internal integration and product quality is also significant under low ($\beta = 0.58$, $p < 0.001$) and high EUs ($\beta = 0.76$, $p < 0.001$) with a significant χ^2 difference ($\Delta\chi^2 = 3.96$, $p < 0.05$), which suggests that the internal integration–product quality relationship is strengthened under a high EU, and hence, supports H4c. Finally, the relationship between internal integration and production flexibility is significant under low and high EUs, but the χ^2 difference test suggests invariance of the relationship across high and low EUs ($\Delta\chi^2 = 1.94$, $p > 0.05$), and hence, supports H4d.

Panel B of Table 6 shows a repeat of the above analysis for the supplier integration–performance paths. We also found significant differences in the χ^2 statistics ($\Delta\chi^2 = 79.19$, $p < 0.05$) between the baseline and constrained models. The results indicated that the relationship between supplier integration and delivery is significant under low ($\beta = 0.65$, $p < 0.001$) and high uncertainty groups ($\beta = 0.72$, $p < 0.05$). While a significant difference in the χ^2 statistics ($\Delta\chi^2 = 3.94$, $p < 0.05$) suggests variance, the difference in β suggests that the supplier integration–delivery relationship is strengthened under high EU, which lends support for H5a. However, the path from supplier integration to production cost ($\Delta\chi^2 = 2.38$, $p > 0.05$), and the path from supplier integration to product quality are found to have an insignificant χ^2 difference ($\Delta\chi^2 = 2.52$, $p > 0.05$), which suggest the absence of a contingency effect, and hence, lend support to H5b and H5c. Finally, the relationship between supplier integration and production flexibility is significant under low ($\beta = 0.40$, $p < 0.05$) and high uncertainty groups ($\beta = 0.62$, $p < 0.05$). A significant difference of the χ^2 statistics ($\Delta\chi^2 = 4.55$, $p < 0.05$) suggests variance of the path across high and low EUs. These results suggest that the supplier integration–production flexibility relationship is strengthened under a high EU, which lends support for H5d.

Lastly, panel C of Table 6 shows a repeat of the above analysis for the paths from customer integration to operational performance. We found significant differences in the χ^2 statistics ($\Delta\chi^2 = 108.16$, $\Delta df = 53$, $p < 0.05$) between the baseline and constrained models. The results showed an insignificant χ^2 difference between high and low EU groups for the relationship between customer integration and delivery ($\Delta\chi^2 = 0.27$, $p > 0.05$), which does not support H6a. The results indicated that customer integration–production cost and the customer integration–product quality relationships are positively significant. However, there are no significant χ^2 differences between the customer integration–production cost relationship ($\Delta\chi^2 = 0.28$, $p > 0.05$) and the customer integration–product quality relationship ($\Delta\chi^2 = 0.47$, $p > 0.05$), and hence, supports H6b and H6c. Finally, a significant χ^2 difference is found between the high and low uncertainty groups ($\Delta\chi^2 = 3.92$, $p < 0.05$) for the path from customer integration to production flexibility; its path coefficients are significant in both high ($\beta = 0.65$, $p < 0.001$) and low uncertainty groups ($\beta = 0.47$, $p < 0.05$). A difference in β shows that the customer integration–production flexibility relationship is strengthened when the EU is high, which lends support for H6d.

5. Discussion and implications

5.1. Discussion of results

The results of the SCI–performance relationships (H1–H3) support our expectations and are largely consistent with prior research studies. Although the value of SCI has been proven by prior studies, our results further justify the value of the three SCI dimensions in an emerging country such as Thailand. Our results offer evidence of the purported impacts of internal, supplier and customer integration on various operational performance outcomes. Previous studies have demonstrated the positive impacts of internal integration on delivery and quality (Dröge et al., 2004; Germain and Iyer, 2006; Swink et al., 2007); our results further provide evidence of the positive impacts of internal integration on production cost and production flexibility. These results reinforce the argument for the need to remove functional barriers (Flynn et al., 2010) and to achieve agreement on consistent purposes and cooperation across functions (Deming, 1982) to reduce cost (Ettlie and Stoll, 1990) and improve flexibility (Sawhney, 2006).

In terms of the value of external integration, our results demonstrate positive impacts of both supplier and customer integration on delivery, product quality, and production cost, consistent with the results of prior studies (Scannell et al., 2000; Rosenzweig et al., 2003; Dröge et al., 2004; Devaraj et al., 2007). Our results further add evidence to the purported positive impacts of supplier and customer integration on production flexibility (Rosenzweig et al., 2003). More importantly, our results indicate the benefits of considering suppliers and customers as the providers of information and collaboration (Galbraith, 1973) which will improve product development, marketing, procurement, production and logistics, and facilitate information exchange (Lee et al., 1997), task coordination (Stank et al., 1999), cross-border problem-solving routines (Flynn and Flynn, 1999), joint cost and inventory reduction (Scannell et al., 2000).

Although the value of SCI has been recognized, previous literature lacks a theory which can explain why in some instances, EU has no effect on an SCI–performance relationship (Koufteros et al., 2005), but in other instances, an SCI–performance relationship could be strengthened or weakened under the influence of EU (O'Leary-Kelly and Flores, 2002). Our results (H4–H6) confirmed that such complex relationships can largely be explained by our proposed theories. Our theories are supported by the results which indicate that internal integration will have greater impacts on product quality and production cost under a high EU because these performance outcomes greatly depend on internal fit, but not external input (Ragatz et al., 2002). These results further support the TQM literature which argues for the importance of constancy of purpose and cooperation across functions as the foundations for improving cost and quality (Deming, 1982; Crawford, 1992). Such foundations will encourage knowledge sharing and development of new skills when a focal firm is faced with an uncertain environment (Roth, 1996; Sitkin et al., 1994). These explanations are confirmed by further interviews with some respondents who suggested that Thailand's automotive industry embraces internal integration to reduce uncertainty by facilitating internal collaboration amongst business functions in response to high production cost and to reduce the defect rate in production (Lai et al., 2008).

Our results further confirm our theoretical premise which suggests that external integration, instead of internal integration, will have greater impact on delivery and production flexibility under a high EU because these performance outcomes are sensitive to external input and collaboration. On the other hand, the absence of moderating effects of EU on the relationships between supplier/customer integration, and product quality and production cost is as expected because these two performance outcomes are less sensitive to external input and collaboration (Ragatz et al., 2002). Further interviews with some of the respondents suggest that delivery performance is one of the most important performance criteria for automotive firms. Also, delivery performance is highly sensitive to external input and coordination. Thus, these firms need to work closely by sharing information and joint planning to ensure continuous input flow, especially when facing a highly uncertain environment.

Even though our results largely support our contingency theories, one of our hypotheses (H6a) is rejected. We theorized that both supplier integration–delivery performance and customer integration–delivery performance relationships are strengthened under a high EU. Our results indicate that only the former, not the latter relationship, is strengthened. To gain an in-depth understanding on this counter-intuitive result, we conducted further interviews with Thailand's automotive industry managers to identify contextually embedded explanations. Our interviewees suggested that customer integration is insufficient to improve delivery performance under a high EU. Instead, internal integration plays a significant role in ensuring coordination between internal functions to improve delivery performance. This is because, under a highly uncertain environment, it is difficult for JIT delivery to the market to correspond with JIT production. As suggested by the interviewees, although they have customer integration to support JIT delivery, internal integration is required to support JIT production and collaboration amongst business functions to achieve delivery performance improvements.

5.2. Implications and contributions to theory

The findings of this paper provide implications and contributions to SCI and OM theories. The first implication is concerned with the conceptualization of constructs. This paper demonstrates the benefits of conceptualizing SCI and operational performance as multidimensional constructs (Dröge et al., 2004; Koufteros et al., 2005; Devaraj et al., 2007; Swink et al., 2007; Flynn et al., 2010). Unlike some previous studies which conceptualize SCI and/or operational performance as unidimensional constructs (e.g., Stank et al., 1999; Rosenzweig et al., 2003), this paper allows us to comprehensively understand the details of SCI–performance relationships at dimension levels. More importantly, the use of multidimensional SCI and performance constructs (Ketokivi and Schroeder, 2004) allows us to develop a comprehensive model and theory of the contingency effects of EU. Knowledge at this level of particularity could not be created without taking approaches like ours.

Perhaps the most significant contribution of this paper is the development and testing of a novel theoretical model on the moderating effects of EU on SCI–performance relationships. The model complements previous studies (O'Leary-Kelly and Flores, 2002; Fynes et al., 2004; Koufteros et al., 2005), and lays the foundations for the development of a contingency theory of SCI. Our contribution lies in the approach in which we integrate CT and OIPT. OIPT allows us to demonstrate the benefit of viewing a focal firm and its environment from an organizational information processing perspective (Galbraith, 1973), and the importance of understanding the distinct mechanisms in which internal and external integration affect the different groups of performance outcomes. Organizational information processing logic serves as the basis to identify two contingencies which were previously not considered in the SCI and OM literature. The first contingency concerns the nature of operational performance outcomes, which can be divided into time-based externally sensitive and non time-based internally dependent performance outcomes. The second contingency concerns the distinct effects of the two groups of SCIs (internal versus external integration) on these two groups of performance outcomes under a high EU. Such a novel approach provides the much needed logical arguments to explain why only some SCI–performance relationships could be strengthened under a high EU. In summary, this paper helps to clarify the tenuous and spotty relationships among EU, SCI and operations performance (Stonebraker and Liao, 2006), and contributes to contingency operations management research (Sousa and Voss, 2008).

5.3. Implications and contributions to practice

In terms of implications for managerial practice, this paper advances the understanding of operations and supply chain managers. Managers are now equipped with theories and supporting evidence which explain why their SCI efforts to cope with a high EU do not always bring about desirable operational performance outcomes. By differentiating internal from external integration, managers can now understand that both supplier and customer integration are paramount in providing input to the operational tasks required to improve time-based and externally sensitive performance outcomes, such as delivery and flexibility under a high EU. This means that managers should focus on investment in external integration to improve time-based performance, such as delivery and flexibility, because these performance outcomes are sensitive to input and collaboration with suppliers and customers, especially under a high EU. For instance, in the context of our study, Thailand's automotive industry is one of the major car exporters in Asia, and faces severe competition with Japan and South Korea in seizing shares in such markets as Southeast Asia, Australia, and the Middle East (Fuller, 2010b). Integrating with suppliers and customers becomes crucial for the automakers to secure components and parts to ensure on-time, reliable, and timely delivery, while maintaining flexibility in product specifications, production volume, customized product features, and product mix changes to compete.

Instead, internal integration is essential for improving non time-based performance and internally dependent performance outcomes, such as product quality and production cost under a high EU. The improvement of product quality and production cost under a high EU can be achieved by putting more effort into internal integration, because the performance outcomes are less sensitive to external input and collaboration, but heavily rely on internal fit across functions. When allocating investment in integration, managers with such knowledge will be more competent in estimating and explaining the performance impacts of various integration efforts.

5.4. Limitation and future research

This paper has some limitations. It attempts to explain the performance implications of SCI under the contingency effects of EU, but the performance explanation is likely to be incomplete because SCI is not the only approach to mitigate negative effects of EU. Although EU is a key factor that affects the performance of operations, it is not the only contingency factor in the SCI–performance relationship. Based on the resource dependency theory (Pfeffer and Salancik, 1978), EU may originate from the nature of inter-organizational dependency (Handfield, 1993). Other means to mitigate such an uncertainty are, for example, acquiring control over resources to minimize dependence on other firms. Thus, when considering inter-dependency as another contingency factor, other aspects of understanding may be created and different managerial implications may emerge. For example, in order to reduce the disturbance of supply uncertainty in a JIT environment, it is advisable to take over the responsibility of inbound logistics (Hill and Vollmann, 1986). Alternatively, legal means may also help to control the environment. For example, the possession of a patent may reduce the negative impacts of technological and competitive uncertainties.

Furthermore, some literature suggests that when integration is coupled with different firm structures, there will be different performance implications under different levels of EU. Miller (1987) argued that integration with bureaucratic mechanisms (with formal control and integration of decisions) is required for a stable environment, and integration with organic mechanisms is more effective for an unpredictable environment. Organic mechanisms such as environment scanning, delegation of authority, and simplification of procedures are able to reduce or mitigate uncertainty. Future studies may extend our research model by including the bureaucratic–organic nature of focal firms, and also explore other contingency factors, such as industrial maturity, order qualifier, level of outsourcing, etc. (Sousa and Voss, 2008).

To understand the complex contingency effects of EU, this paper employs a large-scale survey of a single industry. Although the survey of a single industry has its own advantages, omitting other industries may decrease the generalizability of the results. Thus, further large-scale and cross-sectional research is recommended. However, the use of large-scale studies with surveys offers more statistically generalizable, but potentially superficial findings (Ketokivi and Schroeder, 2004). In addition, the relationships among SCI, operational performance, EU and other contextual factors are rather multi-faceted and complicated (Stonebraker and Liao, 2006). Even though more theory-testing research is required, longitudinal and case studies are recommended to fully understand the mechanisms behind each SCI–performance relationship and the contingency effects of other contextual factors. In order to meet some of the data analysis criteria (Marsh et al., 1998), this paper investigates internal, supplier and customer integration in three separate models, and has therefore ignored the potential interactions among SCI dimensions. Future research should take into account the potential interactions and combined performance impacts among different SCI dimensions (Germain and Iyer, 2006; Flynn et al., 2010). Finally, this paper focuses on the strength of the moderating effects, but further studies on their form (the joint effects of EU and SCI) are required. Such joint effects may be tested using a moderated regression analysis (Venkatraman, 1989).

6. Conclusion

This paper advances SCI research by developing theories and providing empirical evidence to explain the contingency effects of EU on the impacts of three SCI dimensions on four dimensions of operational performance outcomes. Integrating CT and OIPT, this paper develops a novel approach and theory to explain the complex relationships among EU, SCI and operational performance. With this approach, we are able to differentiate the performance mechanism of internal from external integration, and time-based, externally dependent performance outcomes, from non time-based, internally dependent performance outcomes. With this approach, we are able to explain how and why the impacts of certain SCI dimensions on specific operational performance outcomes can be strengthened.

Such an enhanced understanding has implications for operations management contingency research (Sousa and Voss, 2008) and managerial practice. We can further progress from the justification of the value of SCI to the explanation of the contexts to which it is effective. With the theories and findings of this paper, it is now possible for managers to stipulate the environmental conditions to which an appropriate SCI dimension would have on particular operational performance outcomes. However, the search for contingency effects is still at its infancy stage. Our findings lay the grounds to expand SCI research into exploring different means of reducing or mitigating the impacts of EUs, and the understanding of other contingency factors. In addition, more qualitative and quantitative investigations of the inherently complex interactions and relationships among SCI, EU, operational performance and other contextual factors are required.

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