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服務導向供應鏈中不確定性與企業策略及績效之實證探討 (第2年)

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中文摘要： 隨著科技的進步及消費者力量的抬頭，服務產業在經濟體系中所扮演的角色日益加重。相較於製造業以生產實質產品為主要目的，服務業的營運過程充滿著更多的不確定性 (uncertainty)。如何對環境中的不確定性進行了解，並針對此不確定性提出適合的因應策略，以提升企業營運績效，對服務提供者而言，實為刻不容緩的課題。

本研究透過實務資料的收集，了解服務導向供應鏈中，環境不確定性如何對企業之供應鏈策略造成影響，以及兩者之間的適配性是否將反應在企業績效上。具體而言，本研究以過去學者 (Frei, 2006, Shostack, 1987) 提出的文獻為基礎，探討由顧客端所引起的變異是否可反映服務導向供應鏈中的需求不確定，以及企業所提供之服務流程，其複雜度及多樣性是否可反映供應鏈中的供給不確定性。此外，本研究也分別探討服務導向供應鏈中供給不確定性與需求不確定性與供應鏈策略之間的關係，以及供應鏈策略與企業績效之間的相關性。

本研究透過書面問卷方式收集量化資料。在發展適合用來評估各研究變數的量表之後，本研究以台灣服務產業為調查對象，以獲取實務界對此研究主題的看法。所收集到的量化資料並以結構方程模式 (Structural Equation Modeling, SEM) 進行分析，驗證各相關假說。

研究結果顯示，客戶導向的不確定性與流程的變異程度間具有正相關性。由於各服務型企業所面對的不確定性種類及程度各異，在供應鏈策略的選擇上也各自有不同的目標。而不同的供應鏈策略選擇也進一步地為其帶來的不同的彈性及客戶滿意度等績效表現。

本研究主要理論貢獻在於拓展了服務導向供應鏈管理的討論，並且透過實證資料的收集，為各研究變數間的關連性提供了更明確的認知與了解。此研究結果亦可做為相關企業在訂定服務策略及改善績效時之參考依據。

中文關鍵詞： 供應鏈管理，服務導向供應鏈，不確定性，供應鏈策略，企業績效

英文摘要： This paper empirically examines how customer-induced variability, process variability, supply chain strategy, and business performance interrelate in a service firm context. Quantitative data was collected via a questionnaire-based survey. A total of 376 organizations responded and 313 responses were usable. The results indicated a positive association between customer-induced variability and process

variability. Since firms have different levels of variability, each firm will have a different strategic focus. The emphasis of that strategy will, in turn, result in greater flexibility and customer satisfaction. The mediating role of flexibility between strategy and customer satisfaction was also revealed in this study. Knowledge of these relationships can assist practitioners in choosing appropriate strategies to satisfy customers' various needs.

英文關鍵詞： Service supply chain； customer-induced variability, process variability； supply chain strategy； business performance

The influence of variability and strategy of service supply chains on performance

Abstract

This paper empirically examines how customer-induced variability, process variability, supply chain strategy, and business performance interrelate in a service firm context. Quantitative data was collected via a questionnaire-based survey. A total of 376 organizations responded and 313 responses were usable. The results indicated a positive association between customer-induced variability and process variability. Since firms have different levels of variability, each firm will have a different strategic focus. The emphasis of that strategy will, in turn, result in greater flexibility and customer satisfaction. The mediating role of flexibility between strategy and customer satisfaction was also revealed in this study. Knowledge of these relationships can assist practitioners in choosing appropriate strategies to satisfy customers' various needs.

Key Words : Service supply chain; customer-induced variability, process variability; supply chain strategy; business performance

1. Introduction

Supply chain management (SCM) has received much attention in the literature over the past few decades. In light of the important role of service in today's business world (e.g. Ellram, Tate, & Billington, 2004), a great number of researchers recently shifted their research focus from traditional manufacturing-oriented supply chains to service-oriented supply chains. Among these discussions, researchers view service SCM as "the management of information, processes, capacity, service performance and funds from the earliest supplier to the ultimate customer" (Ellram et al., 2004, p. 25). They commonly agree that the service industry differs in nature from manufacturing with regard to its intangibility, simultaneity, heterogeneity and perishability (e.g. Baltacioglu, Ada, Kaplan, Yurt, & Kaplan, 2007; Ellram, Tate, & Billington, 2007; Sampson & Froehle, 2006; Sengupta, Heiser, & Cook, 2006). Therefore, these two sectors require different management approaches.

Variability (called "uncertainty" in some literature) is a constant theme of interest for researchers studying SCM. Incomplete information is believed to be the major source of variability (Argote, 1982) which can make predicting future demand more difficult. Although variability has been explored from different perspectives such as supply (C.-F. Ho, Chi, & Tai, 2005; Lee, 2002; Yi, Ngai, & Moon, 2011), demand (C.-F. Ho et al., 2005; D. C. K. Ho, Au, & Newton, 2002; Lee, 2002; Randall, Morgan, & Morton, 2003; Yi et al., 2011), manufacturing (C.-F. Ho et al., 2005), technology (Randall et al., 2003), competition (Yi et al., 2011), and capacity (Kim, Leung, Park, Zhang, & Lee, 2002), most of these investigations focused primarily on manufacturing-oriented supply chains.

Because of the distinctive characteristics of the service industry (i.e., intangibility, simultaneity, heterogeneity and perishability), service firms are especially likely to face greater variability than other types of businesses (Maull, Geraldi, & Johnston, 2012; Sampson, 2000). According to contingency theory, organizational effectiveness depends on the fit between external environmental factors and the internal resources of an organization (Neu and Brown, 2005). As a consequence, service companies need to understand the variability they face and then match their supply chain strategies to that variability, thus improving their business performance.

This study aims to explore whether a service firm's variability will affect its adoption of various supply chain strategies. Our contribution lies in providing a clearer understanding of the associations between variability, supply chain strategy, and business performance. More specifically, this study aims to answer the following research question:

How does environmental variability in a service supply chain affect a firm's choice of supply chain strategy, and, in turn, how will the choice of supply chain strategy affect business performance?

The remainder of this article is structured as below. The next section reviews literature relevant to this study. The research model and hypotheses developed for this study are then introduced, followed by the research methodology. Sections 4 and 5 present the research results, findings, and discussion. The last section provides our conclusion and recommendations for future research.

2. Theoretical background

Contingency theory suggests that a firm's performance is affected by three variables: environment, strategy, and organizational design (Burns & Stalker, 1961; Homburg, Workman Jr., & Krohmer, 1999; Mintzberg, 1979; Neu & Brown, 2005). In order to achieve superior performance, organizations need to react appropriately to the external environment. In other words, there must be a good "fit" between the environment and the chosen business strategy (Swamidass & Newell, 1987; Venkatraman & Prescott, 1990).

This study applies a contingency framework to explain the relationships between supply chain variability, supply chain strategy, and business performance. In this study, customer-induced variability and process variability are regarded as two main sources of variability that will affect the strategic focus of a firm's supply chain. The adoption of a particular supply chain strategy will then affect the firm's business performance in terms of flexibility and customer satisfaction. The proposed model is depicted in Table 1, below.

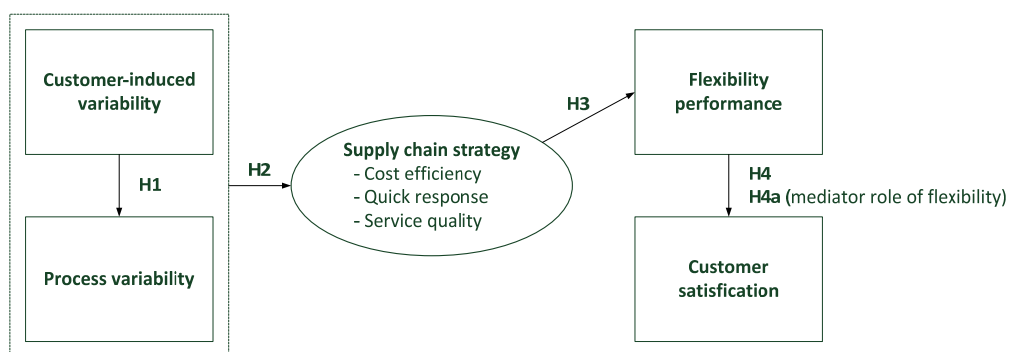


Figure 1. Research model

2.1 Customer-induced variability

According to Larsson and Bowen (1989), customers are the major source of variability in a supply chain. Customer variability is associated with the apparent link between product characteristics and environmental factors, and causes difficulty when a firm attempts to forecast and control future demand for its products or services. This viewpoint is later supported by Davis (1993) who notes that if customers order products or services in irregular quantities or change their preferences, forecasting will be inaccurate. This change will be further reflected in product characteristics such as life cycle, lead time, and stock rate, making supply chain management difficult (Fisher, 1997). A group of researchers led by Gebauer (Gebauer, 2007; Gebauer, Bravo-Sanchez, & Fleisch, 2008; Gebauer, Krempf, & Fleisch, 2008a, 2008b) argues that changes in customer expectations result in service system variability. To respond to such changes, firms must adjust their internal strategy and redesign the organization and the process in order to meet their customers' requirements and improve customer loyalty.

Focusing on service to satisfy customers' needs brings firms financial, strategic, and marketing benefits (Mathieu, 2001a, 2001b). Nevertheless, it causes variability and affects resource planning and output forecasting (Frei, 2006; Kannan & Proença, 2010). Firms that proactively design their service systems to counter such customer-induced variability can open up market opportunities (Kannan & Proença, 2010). Costs incurred during transactions with customers may also be effectively decreased (Jones, 1987).

Frei (2006) proposes a framework for exploring the customer-induced variability from five perspectives: arrival variability, request variability, capability variability, effort variability and subjective preference variability. *Arrival variability* refers to the different times the service is required by customers. Although appointment or reservation systems may help a firm cope with this variability, they work only in certain situations such as in a hospital (Chand, Moskowitz, Norris, Shade, & Willis, 2009) or in a restaurant (Thompson & Kwortnik Jr., 2008). The second type of variability is *request variability*. Because customers' requests do not emerge along standard lines, managing these requests is challenging to service firms. *Capability variability* refers to the varying levels of business-relevant capabilities possessed by the customers of a service business. This variability becomes critical when the customer must actively participate in the production and delivery of a service. On the other hand, customers may have the capabilities to complete a service process, but the amount of effort that they will apply to the work varies. That is *effort variability*, which impacts service quality and cost. Lastly, *subjective preference variability* refers to the different opinions that customers have toward a

service. As stated (Lovelock, 1983), customers' preferences fluctuate. Therefore, they will have different thoughts on what it means to be treated "well" in a service environment. These five forms of variability reflect the sequential process of a service and will affect the firm's operational decisions. Failing to treat variability appropriately, will cause an imbalance of supply and demand in the service system and, in turn, affect service quality and performance in a negative way (Oliva, 2001).

2.2 Process variability

From an organizational perspective, customer-induced variability is associated with a firm's ability, structure and effectiveness (Argote, 1982). Because service firms experience a higher level of customer contact, service systems require specific adjustments in organizational design. The *design* of a service firm is called the firm's "process," and it should be aligned with the company's strategic positioning purposes (Shostack, 1987).

Service is "a series of interactions between participants, processes and physical elements" (Menor, Tatikonda, & Sampson, 2002, p. 138). It should not be viewed as a disconnected collection of pieces and parts (Johnston, 2005; Shostack, 1987). Shostack (1987) introduced the notions of process divergence and complexity in order to provide a better understanding of process in service firms. *Process divergence* was defined as the degree of freedom with which the service process steps or sequences may be altered. *Process complexity* was defined as the number and sophistication of intermediate steps required for carrying out the process, and can be viewed as what organizations do when providing service to customers (Karmarkar, 2004). It can be a simple, standardized process or a series of complex activities. For example, phone marketing and supermarket sales are simple processes while personal financial planning and software design are complex service processes.

Process divergence and complexity provide two useful perspectives in analyzing most service systems. However, a service process can have high complexity and low divergence, and vice versa (Shostack, 1987). Either one may be increased or decreased to allow the company to adjust to external conditions and respond to customer variations (Silvestro, Fitzgerald, Johnston, & Voss, 1992). Consequently, this study formulates the first hypothesis to establish a relationship between customer-induced variability and service firms' process variability:

H1: There is a positive correlation between customer-induced variability and service firms' process variability.

H1a: A higher level of customer-induced variability will lead to higher process complexity.

H1b: A higher level of customer-induced variability will lead to higher process divergence.

2.3 Service supply chain strategy

A great number of researchers have contributed to the body of knowledge regarding supply chain strategies. Within the discussion focusing on the manufacturing sector, cost efficiency and quick response strategies (also known as “lean” and “agile”) are two strategies commonly recognized as helpful in reducing supply chain variability (Christopher & Towill, 2001; Fisher, 1997; Lee, 2002; Mason-Jones, Naylor, & Towill, 2000a, 2000b). Firms focusing on cost efficiency operate business activities at the lowest possible cost. This strategy is appropriate for firms which provide products that have predictable demand, low variety, and long life cycles. On the contrary, firms providing products that have unpredictable demand, high variety, and short life cycles should choose the quick response strategy which aims to be flexible and responsive to the diverse and changing needs of customers.

Just as they are for manufacturing firms, cost efficiency and quick response strategies are critical to service supply chains. Contingency theory suggests that a firm's strategy should be based on the environmental factors; thus, customer-oriented companies adjust their strategies in order to actively manage customer-induced variability (Kannan & Proença, 2010; Sasser, 1976). For example, Skaggs & Huffman (2003) classify three different strategies for service firms: service adaptability strategy, service focus strategy, and customer co-production strategy. Firms who adopt a service adaptability strategy actively alter their service processes to meet customer expectations. Firms adopting a service focus strategy provide the same service process to all customers of a certain service. For firms adopting a customer co-production strategy, customers are treated as part of the process when requesting a service.

Service quality, defined as the extent to which a service fulfills or exceeds customer needs and expectations (Cronin Jr. & Taylor, 1992), is another strategy available to service firms. Frei (2006) proposes that customer-induced variability results in a trade-off between service cost and service quality. Based on the idea that firms choose the trade-

off, four service strategies are generated: classic accommodation, low-cost accommodation, uncompromised reduction, and classic reduction. These strategy classifications represent the various degrees to which an organization is willing to alter its process in order to satisfy customer needs. More specifically, the *classic accommodation* strategy will be adopted by organizations which have a high degree of willingness to alter their service processes to provide what customers want. In contrast, firms that adopt the *classic reduction* strategy are reluctant to provide customized service. They tend to provide standardized services by offering standardized processes. As such, the service cost is low. For those firms who find a position between classic accommodation and classic reduction strategies, the *low-cost accommodation* strategy and the *uncompromised reduction* strategy are potential options.

The association between a service firm's strategic positioning and the complexity of its process has been investigated and established in the literature (Skaggs & Huffman, 2003). Higher levels of process complexity have been found to lead to higher rates of adoption of a customer-focused strategy. Based on a review of the literature, we argue that both process divergence and complexity are crucial to the selection of a service supply chain strategy. Skaggs & Huffman (2003) examined only one of the process perspectives. In order to provide a more comprehensive understanding of this association, our study formulates a hypothesis to explore how process structure and its alignment with customer-induced variability affects the adoption of a strategy. Three major strategies for service supply chains were derived from past studies: cost efficiency, quick response, and service quality. Therefore, we hypothesize:

H2: Service firms at various levels of customer-induced variability and process variability will have various levels of adoption of supply chain strategy.

H2a: Service firms at various levels of customer-induced variability and process variability will have various levels of adoption of cost efficiency strategy.

H2b: Service firms at various levels of customer-induced variability and process variability will have various levels of adoption of quick response strategy.

H2c: Service firms at various levels of customer-induced variability and process variability will have various levels of adoption of service quality strategy.

2.4 Performance: flexibility and customer satisfaction

Flexibility is defined as “the ability to respond or conform to new situations”

(Arias-Aranda, 2003, pp. 1401-1402). Some researchers view flexibility as one of the objectives of managing supply chains (Gunasekaran, Patel, & Tirtiroglu, 2001; Liao, Hong, & Rao, 2010; Stewart, 1995), while others consider it a strategy that can help achieve customer satisfaction (Yi et al., 2011; Zhang, Vonderembse, & Lim, 2003). In the service sector, a firm is considered to be flexible when it can “[introduce] new designs and services into the service delivery system quickly, adjust capacity rapidly, customize services, handle changes in the service mix quickly and handle variations in customer delivery schedules” (Arias-Aranda, 2003, p. 1404). In other words, flexibility represents the performance of a service firm in regards to how well it understands and responds to customer needs. A service system designed with good flexibility can help eliminate the negative influence of environmental variability (Yi et al., 2011), and further improve the firm’s competitive position.

Although flexibility has been discussed extensively from a manufacturing perspective, it remains vague in a service context (Arias-Aranda, 2003). In light of the frequent and important interactions that service firms have with their customers, Arias-Aranda (2003) provides a multidimensional framework adapted from an earlier work (Ramasesh & Jayakumar, 1991) to explore flexibility more comprehensively in a service context. This framework contains seven dimensions: expansion, distribution of information, routing, labor and equipment, market, services and servuction, and process, programming and volume (Arias-Aranda, 2003). Arias-Aranda (2003) applied this framework to service practices, however some dimensions showed low-to-moderate reliability and require further research.

The association between a firm’s cost efficiency strategy and flexibility performance can be explained from the resource’s viewpoint (Beamon, 1999). Since firms focusing on cost will minimize the investment of resources in business operations, this will lead to difficulties in responding to changing customer requirements in terms of volume, delivery and new product. Therefore, we propose that a cost-focused strategy negatively influences flexibility. Additionally, since flexibility aims to handle multiple dimensions of customer-induced variability, quick response and service quality strategies are believed to positively affect a firm’s flexibility performance. Thus, we hypothesize:

H3: There is a significant correlation between supply chain strategy and flexibility performance.

H3a: A higher adoption level of cost efficiency strategy will lead to lower flexibility performance.

H3b: A higher adoption level of quick response strategy will lead to higher

flexibility performance.

H3c: A higher adoption level of service quality strategy will lead to higher flexibility performance.

Customer satisfaction is another important measurement of supply chain performance. In the manufacturing paradigm, this indicator can be influenced by factors such as product quality, delivery speed and capability, cost, flexibility, and innovation (White, 1996). In the service sector, this indicator is even more important since service is customer-centric.

Customer satisfaction refers to the degree to which customers perceive that the products and services they receive are worth more than the price they pay (Tse & Wilton, 1988). Although customer-induced variability has an influence on customer satisfaction, the relationship is believed to be indirect (Kannan & Proença, 2010) because uncontrollable variations (such as employees and equipment) remain in the interfaces between systems and customers. The extent to which these interface variables can gratify the customers determines whether customers are satisfied with the service. In other words, the flexibility performance of a service system is considered to be associated to customer satisfaction.

The relationship between manufacturing flexibility and customer satisfaction has been confirmed by Zhang et al. (2003). Their research revealed that higher flexibility leads to higher customer satisfaction. Similarly, Liao et al. (2010) explored how supply flexibility affects supply chain performance. This association was also found to be positive. In the service sector, Arias-Aranda's (2003) work is one of the few that has confirmed the direct effect of flexibility on a firm's performance. However, the performance indicators of this study (Arias-Aranda, 2003) are not customer-focused. Since our study aims to explore service supply chains from the customers' perspective, we hypothesize as follows:

H4: There is a positive correlation between flexibility performance and customer satisfaction.

The direct effect of flexibility on supply chain performance has been confirmed. However, Arias-Aranda's work (2003) is one of very few studies which address the mediating role of flexibility in this relationship. That study confirmed that flexibility mediates the effect of a service operation's strategy on the firm's financial performance indicators. To further investigate flexibility from a customer-centric service systems and

performance perspective, we hypothesize H4a as follows:

H4a: Flexibility performance mediates the relationship between supply chain strategy and customer satisfaction.

3. Methodology

3.1. Operationalization of variables

This study conducted a structured questionnaire consisting of five parts. To collect background information on the respondent, Part 1 contained questions related to the company profile. Parts 2 through 6 obtained the insights of respondents regarding each research construct: customer-induced variability, process variability, supply chain strategy, flexibility performance, and customer satisfaction.

Part 2 contained 28 items designed to obtain the five types of customer-induced variability. These items were developed based on Frei (2006). Part 3 contained 13 questions used to explore process variability. These items were based on Shostack's (1987) descriptions of process complexity and process divergence. Part 4 contained 18 questions for supply chain strategy, based on relevant literature (Frei, 2006; Lee, 2002; Wang, 2007). Part 5 contained 38 questions for flexibility performance, also based on relevant literature (Arias-Aranda, 2003; Koste, Malhotra, & Sharma, 2004; Zhang et al., 2003). Part 6 contained 10 questions regarding customer satisfaction performance, based on Zhang et al. (2003).

All of the survey questions were answered using a five point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). These items were pretested by the research team and administered to seven EMBA students (medium- to high-level industry managers) and three academic experts. The survey scale development guideline (Hinkin, 1998) was used in this study to develop the measures. Expansion flexibility was initially included but it was removed from the questionnaire because respondents suggested that it could be confused with other flexibility types and was not often considered in practice. The content validity ratio (CVR) (Lawshe, 1975) was then utilized to assess the content experts' judgment of the scales. Ten experts participated in judging a total of 102 items (excluding the five questions regarding expansion flexibility which had been removed). The CVR of 87 items was greater than .75 (the cut-off point is .62 for 10 participants). 15 items with low CVR were deleted.

The result indicates that the proposed model is reliable and acceptable. Comments offered by the experts helped to ensure the questionnaire was relevant and clear to the

respondents. The questionnaire was then refined according to the pre-test results.

3.2. Survey questionnaire development

The survey items were originally in English and were translated and reviewed by two research team members who are fluent in both English and Mandarin Chinese. The survey was later circulated among and pilot-tested by 50 EMBA students and ten senior academics with abundant industry experience. The questions, format, and scales of the questionnaire were examined and verified by these participants. The final instrument revision was then developed according to the comments, assessments, and suggestions from these experienced academics.

3.3 Sample and data collection

This study employed an internet-based survey to collect data to take advantage of the benefits that such a survey can bring to researchers (Pitkow & Recker, 1995). The survey targeted service industry firms in Taiwan. With the assistance of a marketing research firm in Taiwan, a total of 3,000 emails were sent randomly to individuals within the firm's database. Large to medium-sized service companies from a broad cross-section of industries were sampled, thus minimizing uncontrollable and idiosyncratic effects of any particular sector and ensuring the external validity of the empirical results (Tippins & Sohi, 2003).

The analysis unit in this study was an organizational unit. To answer the questionnaire, the respondents were required to have an understanding of their firm's customer characteristics, service capability, supply chain strategy, and performance. Therefore, we determined that the key informants were corporate or departmental managers and targeted them as the survey respondents.

Filter questions were used to screen out respondents who lacked sufficient knowledge to answer the survey questions. Completed questionnaires were automatically sent to the database and evaluated in terms of usability and reliability. In total, 376 completed responses were received; 313 responses were usable for further analyses. The response rate was 10.43%, higher than the realistic estimate of 5-10% (Alreck & Settle, 2004).

The background information of the firms who responded to the survey is displayed in the table below. Of the responding individuals, most respondents were in positions

above middle management (74.8%). Therefore, study results can be assumed to be representative of key managerial decision-makers. A wide range of sizes amongst the participating firms was desired to ensure an expanded set of organizational structures and strategic orientations (Stock, Greis, & Kasarda, 2000). Firms in the sample represented 13 different NAICS sectors, and 69.3% of the sample firms had been established for more than ten years. Furthermore, some firms identified themselves as manufacturing firms in our survey. This finding also supports the argument that most firms are positioned somewhere along a continuum between service and manufacturing. Very few companies can be regarded as being purely service or manufacturing (Brax, 2005; Jacob & Ulaga, 2008; Oliva & Kallenberg, 2003; Sampson & Spring, 2012).

Table 1. Self-reported respondent characteristics

Respondent characteristics		No. of respondents	Percent
Respondent position	Top level managers	62	19.8
	Middle level managers	172	55.0
	Bottom level managers	79	25.2
Employees	>501	87	27.8
	201~500	39	12.5
	101 ~200	41	13.1
	51 ~100	51	16.3
	<50	93	29.7
Age of firm	No response	2	
	>31	65	20.8
	25~30	36	11.5
	21~25	28	8.9
	16~20	43	13.7
	11~15	45	14.4
	6~10	45	14.4
NAICS groups presented by respondents	<5	44	14.1
	No response	7	2.2
	Computer systems design services/Computer programming services	97	31.0
	Manufacturing	72	23.0
	Wholesale and retail trade and direct marketing	21	6.7
	Construction and real estate	17	5.4
	Health care and social assistance	16	5.1
	Financial and insurance activities	16	5.1
	Publishing and education	11	3.5
	Professional, scientific and technical services	10	3.2
	Accommodation and food services	9	2.9
	Arts, entertainment, and recreation	7	2.2
	Transportation and warehousing	7	2.2
	Mass communication	4	1.3
Other services (except public administration)	26	8.3	

Note: NAICS, North American Industry Classification System

4. Results and findings

Descriptive data including means and standard deviations for all survey items are shown in Tables 3 through 7.

4.1 Reliability and validity of measures

The measures were reliable with alpha values ranging from .85 to .93 (Hair, Black, Babin, Anderson, & Tatham, 2006). (See Table 2.) The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used to validate the use of factor analysis. The KMO measures for all categories were above .850, indicating that the factor analysis was appropriate (Kaiser, 1970).

Table 2. Results of KMO Bartlett's Test of Sphericity

Factor	Cronbach's α	KMO
Customer-induced variability	.85	.924 ^{***}
Process variability	.89	.850 ^{***}
Supply chain strategy	.83	.926 ^{***}
Flexibility performance	.93	.957 ^{***}
Customer satisfaction	.93	.926 ^{***}

Note: The p-values of Bartlett's Test of Sphericity are listed next to each KMO. * p < .05. ** p < .01. *** p < .001.

Factor analysis was then used to reduce the total number of items to a smaller number of underlying factors to test construct validity. It was performed using principal component analysis as the extraction method and Varimax as the rotation method. The results are shown in Tables 3 through 6, below.

According to Frei's (2006) and Arias-Aranda's (2003) frameworks, we retained five factors for customer-induced variability and six factors for service flexibility. Three types of supply chain strategy were extracted from the literature and measured in this study. Based on the factor analysis result, we first eliminated two items with low loadings on all factors (lower than .4) and six items with high cross-loading (higher than .4) on two or more factors. The remaining 79 items were again factor analyzed. Each item was found to load strongly on only one factor. The Kaiser-Meyer-Olkin (KMO) measures of four major multi-dimension constructs indicated that factor analysis resulted in distinct, reliable factors, and the Bartlett's Test of Sphericity verified that relationships existed among the items (Tables 3 through 6). The results also indicated that all items had lower loadings on the irrelevant factors. Thus, these statistics confirm the unidimensionality,

reliability, and convergent validity of the constructs. Content validity was established through a content expert's judgment and a careful review of existing literature.

Table 3. Factor analysis result and descriptive statistics of customer-induced variability

Items	1	2	3	4	5	Mean	SD
Arrival variability ($\alpha = .833$)							
There are large fluctuations in our customers' purchase frequencies	.214	.254	.118	.748	.136	3.56	.946
The number of customer-visit fluctuates significantly over business hours	.164	.334	.198	.793	.190	3.42	.964
The arrival intensity of our customer changes over business hours	.231	.284	.167	.780	.186	3.47	.906
We have clear seasonal fluctuation in the number of customer-visit	.018	.157	.085	.872	.111	3.41	.950
The number of customer-visit varies during peak hours and off-peak hours	.170	.031	.262	.752	.388	3.50	.920
Request variability ($\alpha = .890$)							
Our customers have additional requirements for a variety of reasons*						3.50	.866
Our customers differ in how they want the services to be customized	.806	.188	-.012	.014	.207	3.64	.855
Our customers require different service levels	.863	.190	-.041	.090	.151	3.58	.852
Our customers differ in the ways they want the services to be delivered	.801	.181	.178	.202	.131	3.48	.840
Our customers differ in their opinions toward our services	.661	.119	.394	.206	.082	3.49	.851
Capability variability ($\alpha = .919$)							
Customers differ in their level of familiarity of our services	.064	.162	.377	.126	.651	3.45	.901
Our customers differ in their ability to collect product/service information	.033	.112	.332	.196	.671	3.42	.920
Our customers require different levels of explanation	-.074	.213	.331	.179	.762	3.47	.916
Customers differ in their understanding of our services	-.073	.153	.245	.167	.770	3.53	.944
Our customers require different levels of advisory	-.039	.097	.251	.151	.795	3.50	.896
Effort variability ($\alpha = .852$)							
Our customers differ in their willingness to offer comments about desired services**						3.43	.830
Our customers differ in their willingness to communicate their satisfaction directly to the company**						3.44	.868
Customers differ in their level of participation in our company's quality improvement activities	.261	.377	.640	.115	.219	3.54	.824
Our customers differ in their willingness to participate in service recovery	.291	.235	.755	.172	.137	3.50	.878
Our customers differ in their willingness to provide personal information	.365	.251	.676	.245	.149	3.46	.866
Subjective preference variability ($\alpha = .883$)							
There is a large difference in our customers' likeness toward our services	.198	.813	.181	.212	.133	3.48	.888

Our customers' preferences are quite different in the way services are delivered	.200	.842	.149	.234	.086	3.53	.881
There is a large difference in customer preferences for our service items	.257	.805	.184	.215	.076	3.42	.920
Our customers' preferences are always changing	.148	.591	.344	.354	-.014	3.33	1.027
Our customers have diverse personal preferences for service**						3.57	.868

Extraction method: principal component analysis; rotation method, varimax with Kaiser normalization.

a. Rotation converged in seven iterations.

* Item deleted due to low loadings on all factors, ** item deleted due to high cross-loadings on two or more factors.

Table 4. Factor analysis result and descriptive statistics of process variability

<i>Item</i>	1	2	Mean	SD
Process complexity ($\alpha=.896$)				
We often need to change the number of service steps according to the situations	.731	.161	3.61	.863
Our service requires lots of steps	.839	.067	3.60	.897
Our service steps are more than industry average	.852	.124	3.26	.962
Our services sometimes need to take complicated and sophisticated preparation or procedures	.870	.151	3.31	.946
Our service personnel often need to switch between different processes	.856	.153	3.49	.958
Process divergence ($\alpha=.926$)				
We have many different ways to integrate our existing services processes*			3.70	.807
The workflow and procedures can be tweaked by our service personnel to better meet customer needs	.149	.880	3.03	1.060
The process steps can be amended by our service personnel to better meet customer needs	.131	.941	2.90	1.079
Our service personnel need not to follow the exact sequence of service step	.115	.932	2.91	1.081
Our service personnel can choose preferred method of service delivery	.165	.817	3.18	1.011

Extraction method: principal component analysis; rotation method, varimax with Kaiser normalization.

a. Rotation converged in three iterations.

* Item deleted due to low loadings on all factors

Table 5. Factor analysis result and descriptive statistics of supply chain strategy

<i>Item</i>	1	2	3	Mean	SD
Cost efficiency strategy ($\alpha=.873$)					
We maintain our competitive advantage by keeping costs down	.316	.165	.677	3.88	.870
We maintain strict control over the cost of each process	.304	.114	.613	3.61	.955
We focus on cutting costs more than our competitors	.371	.162	.722	3.70	.951
We maintain strict control over the acquisition costs equipment and materials	.115	.267	.813	3.85	.795
We have a high level of control over variable costs	.023	.393	.724	3.95	.694
Quick response strategy ($\alpha=.928$)					
We aim to drive an increase in speed and response time for all supply chain participants	.270	.721	.310	3.83	.798
We maintain our competitive advantage by providing rapid response to market needs	.319	.795	.257	3.79	.860
We emphasize on the ability to respond to changes in the market much faster than our competitors	.362	.773	.259	3.77	.891
We emphasize on the quickest possible responses to customer needs	.328	.804	.212	3.79	.849
We emphasize on quick sharing of information among supply chain participants	.318	.800	.148	3.69	.904
Service quality strategy ($\alpha=.929$)					
We maintain strict control over the service quality standards	.731	.343	.191	3.96	.771
We maintain our competitive advantage by giving our customers the best possible service quality	.771	.353	.170	3.91	.871
We aim to achieve the highest quality in our services	.753	.391	.172	4.01	.832
We believe service quality is a key strategic priority	.761	.325	.326	3.87	.848
We focus on achieving a higher level of service quality than our competitors	.774	.326	.244	3.92	.862

Extraction method: principal component analysis; rotation method, varimax with Kaiser normalization.

a. Rotation converged in eight iterations.

Table 6. Factor analysis result and descriptive statistics of flexibility performance

<i>Item</i>	1	2	3	4	5	6	Mean	SD
Servuction flexibility ($\alpha=.942$)								
We can add more service items quickly and cost effectively	.786	.210	.201	.202	.232	.268	3.53	.858
We can change service items quickly and cost effectively	.800	.206	.145	.238	.288	.185	3.53	.832

We can cost-effectively add or substitute services according to the changes in demand	.757	.209	.246	.279	.223	.175	3.58	.851
We can cost-effectively provide customers substitute services in unexpected situations	.673	.170	.281	.304	.248	.116	3.59	.839
We can quickly provide customers substitute services in unexpected situations	.569	.254	.258	.363	.273	.198	3.64	.858
Market flexibility ($\alpha=.933$)								
Our services are made to meet different market demands	.264	.256	.230	.647	.341	.084	3.71	.810
We can quickly design new services that meet customers' new demands	.369	.275	.270	.643	.249	.237	3.61	.863
We can rapidly adapt to ever-changing marketplace	.260	.292	.119	.729	.282	.267	3.63	.849
We can rapidly reset the time-to-market for our new products/services	.322	.114	.288	.685	.288	.245	3.52	.916
We can make rapid reposes to the needs of target market	.363	.177	.288	.612	.259	.331	3.58	.900
Process flexibility ($\alpha=.940$)								
We can rapidly design new processes for new services	.351	.220	.267	.336	.283	.667	3.60	.827
We can rapidly standardized the new processes	.290	.202	.333	.307	.359	.651	3.59	.855
We can flexibly adjust the level of standardization of the service processes	.300	.216	.324	.333	.293	.641	3.61	.859
We can quickly and flexibly increase service volume**							3.61	.866
We are able to make changes in the production volume of goods or services according to the demand**							3.61	.856
Distribution of information flexibility ($\alpha=.938$)								
We can flexibly adopt information technology to share distribution information with our partners	.275	.222	.281	.206	.597	.355	3.65	.854
We can quickly and effectively share information of customer needs with distribution partners	.329	.269	.220	.244	.675	.327	3.61	.867
We are able to adopt a multiple channel approach	.241	.205	.276	.340	.654	.326	3.59	.865
We openly share customer information across all distribution partners	.281	.224	.242	.351	.703	.025	3.47	.954
We can quickly and effectively refine our distribution channels to meet the needs of target segments and customers	.274	.170	.268	.289	.774	.205	3.57	.893
Personnel flexibility ($\alpha=.926$)								
Our service personnel can give real time support to each other in their work	.209	.826	.226	.123	.112	.195	3.73	.811
Our service personnel react quickly and resolve unexpected problems	.140	.835	.292	.206	.148	.120	3.67	.803
Our service personnel use different knowledge and techniques to perform different tasks	.177	.817	.229	.217	.195	.085	3.73	.792

Our service personnel can ingeniously apply possible processes to service customers	.213	.663	.362	.174	.316	.102	3.72	.795
Our company can flexibly reallocate employees in the time of manpower shortage**							3.67	.865
Routing flexibility ($\alpha = .949$)								
We developed alternative procedures for our services	.249	.330	.725	.198	.322	.171	3.57	.860
We can quickly use alternative procedures to ensure services	.199	.359	.722	.264	.280	.197	3.60	.871
We can deliver our services in number of ways	.228	.328	.738	.209	.248	.183	3.67	.796
We can quickly offer alternative services to resolve unexpected problems	.256	.307	.673	.251	.234	.270	3.67	.826
We can quickly start a replacement process or procedure to resolve unexpected problems	.287	.315	.641	.273	.195	.279	3.64	.844

Extraction method: principal component analysis; rotation method, varimax with Kaiser normalization.

a. Rotation converged in seven iterations.

** item deleted due to high cross-loading on two or more factors.

Table 7. Descriptive statistics of customer satisfaction

<i>Item</i>	Mean	SD
Customer satisfaction ($\alpha = .944$)		
Customers are always satisfied by our high quality performance	3.87	.695
Customers perceive they are getting greater value for the price they are paying for our services	3.89	.712
Customers are always satisfied with the cost/ performance ratio of our services	3.85	.737
Customers are always satisfied with their interactions with our service personnel	3.93	.732
Customers are satisfied with the overall experience of our services	3.95	.682
We have earned the most customer satisfaction than other competitors in the market	3.88	.782
We have a reputation for a higher cost-performance ratio than other competitors among customers	3.88	.767

4.2 Hypothesis testing

H1 (H1a and H1b):

To test H1a and H1b, we calculated Pearson's correlation coefficient. This coefficient measures the strength of a linear relationship between two variables. An examination of the types of customer-induced variability and process variability revealed that all five types of customer-induced variability are associated with process complexity at a medium to strong level (correlation coefficients ranging from .312 to .504). The five types are relatively less strongly associated with process divergence at close to a medium level (correlation coefficients ranging from .203 to .270). All are significant (at $p < .001$; see Table 8). We thus conclude that both H1a and H1b are supported.

Table 8. Correlations of customer-induced variability and process variability

(Process variability)	(Customer-induced variability)				Subjective preference
	Arrival	Request	Capability	Effort	
Process complexity	.380***	.504***	.483***	.483***	.312***
Process divergence	.203***	.263***	.265***	.270***	.207***

H2 (H2a, H2b, and H2c):

H2 posits that firms with various levels of customer-induced and process variability will adopt the three types of supply chain strategy at differing levels. To test this hypothesis, we classified the respondents into groups by conducting K-mean cluster analysis which is often used in SCM literature (e.g. Lai, 2004; Qi, Boyer, & Zhao, 2009; Zhu, Geng, & Lai, 2010). The literature suggests that the number of clusters should be between $n/60$ and $n/30$, where n is the sample size (Lehmann, 1979). Since the sample size is 313 in this study, the ideal cluster number was expected to be between 6 and 10. However, when we classified the respondents into clusters of these sizes, we found that the samples of at least three of the clusters are unacceptably small (less than four). The situation was the same when we grouped them into five clusters. We then tried four clusters. The grouping result shows that the sample sizes of these clusters are 103, 160, 48, and 2. Although there was still one group with an unacceptably small number of cases, the previous three groups represent firms with high, medium, and low levels of variability (as shown in Figure 2, below). We recognize that this classification is appropriate for our study purpose of exploring how firms with different levels of variability will behave when choosing a supply chain strategy. Furthermore, the grouping of respondents into

three clusters is also common in the literature (e.g. Chun & Wei, 2006; Gupta & Narain, 2012; Paulraj, Chen, & Flynn, 2006). Therefore, we decided to remove the two samples of the fourth group from our sequential analysis.

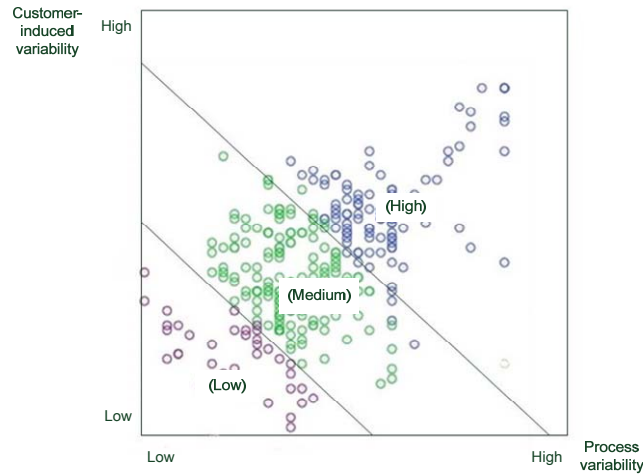


Figure 2. K-mean cluster grouping result

ANOVA (analysis of variance) was then utilized to test this hypothesis, and the Scheffé method was utilized to test for significant differences between these groups. The result is shown in Table 9. The result indicates that significant differences at .05 level were found in all three of the supply chain strategies. In other words, firms with various levels of variability have adopted the three supply chain strategies at different levels. H2a, H2b, and H2c are thus supported.

Table 9. ANOVA result of supply chain strategy by variability levels

(SC Strategy)	(Variability level)			F
	High (N=103)	Medium (N=160)	Low (N=48)	
Cost efficiency	4.095 ^(M, L)	3.646 ^(H)	3.638 ^(H)	10.843 ^{***}
Quick response	4.025 ^(M)	3.639 ^(H)	3.679	6.019 ^{**}
Service quality	4.214 ^(M, L)	3.784 ^(H)	3.817 ^(H)	8.039 ^{***}

*Alphabets in parentheses indicate group number from which the group is different (Scheffé pairwise test with significance level .05).

H3 (H3a, H3b, and H3c):

Regression analysis was conducted to test this set of hypotheses. The result is shown in Table 10. The standardized beta coefficient shows that cost efficiency strategy is positively related to flexibility performance ($p < .001$). H3a is not supported. Further, both quick response and service quality strategies significantly and positively influence flexibility performance at a significance level of .001, supporting H3b and H3c.

On closer examination of the results from the three variability level groups, we see that cost efficiency strategy does not affect flexibility performance significantly in the high variability group of firms. Similarly, the influence of service quality strategy is not significant to the low variability group. In other words, the influence of the supply chain strategy on flexibility performance varies with the level of variability faced by the firm.

Table 10. Regression result of supply chain strategies on flexibility

(SC strategy)	Overall flexibility	(Variability level)		
		High (N=103)	Medium (N=160)	Low (N=48)
Cost efficiency	.219*** (1.955)	.080 (2.786)	.170** (1.536)	.308**
Quick response	.486*** (2.224)	.515*** (2.553)	.402*** (1.918)	.424***
Service quality	.248*** (2.455)	.330*** (2.501)	.218*** (2.087)	.133
R ²	.724	.760	.649	.708
Adjusted R ²	.722	.752	.642	.688
F	270.649***	104.232***	96.149***	35.604***

* $p < .05$; ** $p < .01$; *** $p < .001$; VIFs shown in parentheses.

H4 and H4a:

To test H4, Pearson's correlation coefficient was calculated. The result indicates that the coefficient is .585 at the .01 significance level, representing a strong correlation between variables (Cohen, 1988). If we take a closer look at the data, the correlations were found to be medium to strong in the groups of high, medium, and low variability levels (the coefficients were found to be .663, .407, and .647, respectively—all significant at a level of .001). Further examination also revealed that customer satisfaction is associated with each of the flexibility perspectives at a medium to strong level (Table 11). Thus, H4 is supported.

Table 11. Correlations of flexibility and customer satisfaction

	Overall flexibility	Servuction	Market	Process	Distribution	Personnel	Routing
Customer satisfaction	.585***	.510***	.558***	.537***	.503***	.528***	.490***
High (N=103)	.663***	.577***	.630***	.638***	.586***	.579***	.623***
Medium (N=160)	.407***	.311***	.406***	.371***	.291***	.428***	.294***
Low (N=48)	.647***	.617***	.606***	.589***	.536***	.437***	.555***

*p<.05; **p<.01; ***p<.001

In H4a, we hypothesized that flexibility performance mediates the relationship between supply chain strategy and customer satisfaction. The mediation effect was examined using procedures specified by (Baron & Kenny, 1986). A partial mediation of flexibility was supported since the beta coefficients of supply chain strategies were diminished when both supply chain strategy and flexibility scores were entered into the model.

However, if we take a closer look at the three groups of high, medium, and low level variability, we find that the beta coefficients of the quick response strategy increase and change from positive to negative in the high and low variability groups. A similar situation is also found in the beta coefficient of the cost efficiency strategy in the low variability group. Although these changes are not statistically significant, we suspect the mediation effect of flexibility varies with the level of variability encountered by the firm. Therefore, we conclude that this hypothesis is partially supported.

Table 12. Regression result of supply chain strategies on flexibility

(Independent variables)	(Overall)		(Variability level)					
	Customer satisfaction		High (N=103)		Medium (N=160)		Low (N=48)	
Cost efficiency	.093 (1.955)	.034 (2.128)	.065 (2.786)	.031 (2.812)	.067 (1.536)	.059 (1.633)	.035 (1.775)	-.098 (2.125)
Quick response	.220** (2.224)	.090 (3.083)	.106 (2.553)	-.115 (3.878)	.220** (1.918)	.202* (2.566)	.068 (2.157)	-.114 (2.973)
Service quality	.365*** (2.455)	.299*** (2.679)	.469*** (2.501)	.327** (2.882)	.177* (2.087)	.167 (2.288)	.459** (2.878)	.402** (2.971)
Flexibility		.268** (3.628)		.430** (4.159)		.047 (2.849)		.431** (3.428)
R ²	.376	.396	.433	.493	.237	.238	.454	.512
Adjusted R ²	.370	.388	.416	.472	.222	.218	.417	.467
F	62.176***	50.522***	25.241***	23.781***	16.130***	12.071***	12.212***	11.293***

*p<.05; **p<.01; ***p<.001; VIFs shown in parentheses.

5. Discussion and implications

5.1 Main effects

H1 (H1a and H1b):

Our result supports a significant and positive relationship between service companies' customer-induced variability and process variability, namely process complexity and process divergence. This result reflects the important role of the customer in today's service firms. Frequent interactions with customers drives today's service businesses to adopt diverse and flexible process designs. Their service employees are also empowered to deal with their customers' changing needs and wants in the service production and delivery processes.

The survey data analysis further revealed that the five types of customer-induced variability are more strongly correlated to process complexity than they are to process divergence. As stated, altering elements of the production process can help service firms respond effectively to the variability generated by customer interaction (Skaggs & Youndt, 2004). This finding also reflects that although today's service firms devote most of their efforts to satisfying their customers, they focus mainly on adjusting their approach or procedures rather than focusing on the content of the service. In other words, the services they provide to customers retain a high level of similarity with a variety of different approaches. This also echoes Jones (1997) who states that the transaction characteristics (variability) are positively related to the level of governance structure complexity.

H2 (H2a, H2b, and H2c):

The survey data confirms the hypothesis. More specifically, firms in an environment of high-level variability apparently emphasize all of the three types of strategy explored (i.e., cost efficiency, quick response, and service quality). A closer examination reveals that although firms with high levels of variability adopt these strategies at levels that differ significantly from the adoption levels of firms at medium and low levels of variability, the difference between the strategy adoption levels of the medium and low variability level firms is not so significant. There appears to be a frontier between the groups with high and medium levels of variability. Once firms face more than a particular level of variability, they will devote significantly more effort to selecting a strategy. However, if the service firm's level of variability is still manageable, the adoption of a strategy will not be considered such an urgent decision.

H3 (H3a, H3b, and H3c):

Understanding the effect of supply chain strategy on flexibility performance was one of our major objectives. The result indicates that the three supply chain strategies do influence flexibility. An overall examination finds that the three strategies are positively related to a service firm's flexibility performance.

According to our survey results, the quick response strategy is the strategy that most strongly influences flexibility performance. Since the quick response strategy aims to enhance the reaction to market variability, it drives the business to greater flexibility (Lee, 2002). This is similar to the service quality strategy. Service quality strategy aims to satisfy customers' needs and expectations. Therefore, a firm that is strongly committed to fulfilling customer needs will set customers as the priority and adapt its operations accordingly. This adaptation further enables the firm to quickly respond to its customers' changing needs.

The resource-based perspective suggests that focusing on cost results in limited investment in business operations. This study thus posited that the cost efficiency strategy would create a barrier to a timely response and reduce a firm's flexibility to accommodate market changes. However, this was not supported by the survey results. The results reveal that the cost-focused strategy influences flexibility performance in a positive way. As stated (Das & Elango, 1995), although cost and flexibility has been an age-old trade-off in the literature, research has found that the firm that is the lowest cost producer is not necessarily the most flexible firm in the market. Rather, the producer with the highest cost tends to be the firm with superior flexibility performance. Establishing generalized service processes or purchasing equipment with a variety of uses will contribute to a firm's flexibility in a positive way. Therefore, it is possible to find a balance between cost efficiency and flexibility. They are not mutually exclusive.

When we more closely examine the relationship between supply chain strategy and flexibility performance from the variability level perspective, a couple of points are noteworthy. Among the three supply chain strategies we explored, the quick response strategy influences flexibility the most. However, the influence of cost efficiency on flexibility is not significant to the group of high variability firms. Similarly, the influence of service quality on flexibility is not significant to the group of low variability firms. In other words, the impact of a specific supply chain strategy on flexibility varies with the environment's level of variability. Therefore, environment variability matters to firms that intend to improve flexibility by adopting a supply chain strategy.

H4:

This study also confirms that high flexibility performance improves overall customer satisfaction. Interestingly, the survey results identify a strong association between flexibility and customer satisfaction in the two extreme groups with high and low levels of variability. Nonetheless, only a medium level of association was found in the group with medium level variability (see Table 11). The findings are consistent with past studies showing that the elements of flexibility are more important in certain environments than in others (Slack, 1987; Stevenson & Spring, 2007). Therefore, if firms expect to improve overall customer satisfaction via flexibility, they first need to adjust their expectations of the result in accordance with their environmental factors.

The findings also support that the six perspectives of flexibility contribute to a high level of customer satisfaction, echoing Arias-Aranda's (2003) findings of the direct, positive and significant effects of flexibility on non-financial performance. Since customer satisfaction is one of the major non-financial performance indicators for service firms, the significant role of flexibility provides a guideline to practitioners in meeting customers' needs and expectations.

5.2 Mediation effects

H4a:

This study found that flexibility performance plays a partially mediating role. Although H3 confirms the significant relationship between supply chain strategy and flexibility performance, supply chain strategy apparently does not influence customer satisfaction directly. This is because most of today's service firms have adapted their business operations to meet varying customer demands, regardless of the chosen strategy. By providing a set of services which can be compliantly changed by first-line employees, firms expect customer satisfaction to be enhanced. Therefore, rather than directly selling their strategic focus to customers, service firms are advised to accommodate with flexibility.

After examining the effects of supply chain strategy and flexibility on customer satisfaction in the three variability levels, we found that the medium group performs differently compared to the other two. In the medium variability level group, flexibility does not play a significant role; quick response does. This finding echoes our deduction in H4 that the association of flexibility and customer satisfaction is apparently stronger in the two extreme variability groups than in the medium one. Secondly, this result indicates

that, since most firms (160 out of 311) belong to the medium variability group, focusing on a quick response strategy can efficiently increase customer satisfaction. We suspect this is because the medium group of firms may not yet have matured to the point where their customers can clearly specify the characteristics of a well-performed service. The “response time,” therefore, appears to be the most popular and measurable indicator. Consequently, among the three strategy types that contribute to customer satisfaction, the quick response strategy is most salient for the medium group. However, for the two extreme groups (facing high or low variability), service quality remains important after flexibility enters the model. We explain this finding from the perspective of customers’ service expectations. When customers receive services from firms in the two extreme groups, their service expectations are more specific and not focused solely on the speed of the response. Therefore, to satisfy these customers, firms emphasize service quality more. Response speed is not the major concern for these groups.

The cost efficiency strategy does not significantly influence customer satisfaction regardless of the level of variability in the environment. This further reflects the customer attitude and belief that if today’s service firms can provide service within a reasonable time and at a satisfactory quality, cost is not such a big concern. In other words, emphasizing a cost efficiency strategy will not help to increase customer satisfaction. Customers care more about having their needs satisfied than they care about the cost.

6. Conclusion and future research

With the framework of contingency theory, this study explores how a service firm’s customer-induced variability and process variability affect its supply chain strategy, and, in turn, flexibility performance and customer satisfaction. Although the data is exploratory in nature, it provides a clearer understanding of how firms should choose a supply chain strategy that is appropriate to their business environment.

A number of conclusions can be drawn from this study. It is apparent that customer-induced variability is more strongly related to process complexity than to process divergence. It also seems to be true that today’s business firms have been highly accommodating in their business operations in order to deliver their services according to their customers’ preferences. Rather than providing a variety of services, focusing on a select group of services while offering various delivery approaches appears to be a good way to manage customer-induced variability.

Our research results also suggest a frontier between the high and medium levels of variability, at which point firms determine how much they will emphasize each of the

three supply chain strategies. Consequently, for firms with high process variability and high customer-induced variability, we suggest adopting a hybrid strategy rather than focusing on a single strategy. Although perhaps more difficult to manage, a hybrid strategy has a better chance of success in a high variability environment.

The association between supply chain strategy and flexibility performance was examined and confirmed as positive. Consequently, service firms can expect to improve their flexibility performance by adopting the cost efficiency, quick response, and customer satisfaction strategies. However, for firms with high levels of customer-induced variability and process variability, focusing on cost is not a favored approach. Similarly, the effect of service quality on flexibility is also limited in a low variability environment. Furthermore, a flexible service system will result in high customer satisfaction. To meet customer expectations, firms need to be agile and market-sensitive. As such, they can quickly respond to changes in the market.

6.1 Future research

While this study has some limitations, there are also numerous opportunities for further research. First, the data for this study were collected from the service industry in Taiwan; the sample was relatively small and not representative of either Taiwan or the global industry as a whole. Generalizability is limited, so caution must be taken when interpreting the results. Also, other potential moderator variables should be examined in future research, including competition and institutional factors. A further extension of the conceptual framework along with statistical validation may also be needed.

Moreover, customer-induced variability can be seen as the service organization's incomplete information about what, where, when, and how customer input is going to be processed to produce desired outcomes (Martin, Horne, & Schultz, 1999). Future studies should look into any feedback mechanisms (i.e., customer participation) used by service firms to mitigate the effect of customer-induced variability. The proposed frontier between the high and low levels of variability when firms determine to adopt one or more supply chain strategies also requires further exploration.

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行政院國家科學委員會補助國內專家學者出席國際學術會議報告

102 年 7 月 1 日

附件三

報告人姓名	羅明琇	服務機構及職稱	國立政治大學企業管理學系 助理教授
會議時間 地點	102 年 6 月 7 日至 12 日 Dublin, Ireland	本會核定 補助文號	100-2410-H-004-012-MY2
會議名稱	(中文) 第二十屆 EurOMA 國際年會 (英文) 20 th International Annual EurOMA (European Operations Management Association) Conference		
發表演文 題目	(中文) 永續供應商管理方法對交易成本的影響 (英文) The effect of supplier relationship management (SRM) practices on exchange cost when going green		

一、參加會議經過

本屆 20th International Annual EurOMA (European Operations Management Association) Conference 於 102 年 06 月 06 日至 12 日於愛爾蘭都柏林地區舉行。本次研討會由 University College Dublin 及 Trinity College Dublin 共同主辦，假 University College Dublin 及 Trinity College Dublin 場地舉行，參加對象包括來自世界各大學學者，各研究單位研究人員，以及相關產業界人士共計六百餘人。

本研討會同時也邀請 BWG 集團 CEO 於開場時介紹目前流通業所遭遇的挑戰，以及這些挑戰如何與學界相關領域做結合，透過產學合作方式，創造出長期的穩定性產品及生產流程。此外，也邀請了 University College Dublin 的教授 Mark Pagell，針對美洲與歐洲博士生的培訓方法作了比較，並且給在場的所有學界提出建議，如何融合雙方優點，培育中對產學界可有所貢獻的未來優秀人才。

此研討會總計收錄作業管理領域相關研討會文章 397 篇，每篇皆以口頭報告 (Oral Presentation) 的方式呈現。這些文章總共分成二十個會議室進行，每篇文章約有三十分鐘的報告及討論時間。研討會文章包含廣泛的作業管理領域相關主題，例如：供應鏈管理，績效管理，創新管理，電子商務，以及配送系統等等。

本人的文章被大會安排在 6 月 9 日下午的第一個時段進行報告，該時段主題為“Sustainability in Operations and Supply Chain management 1”，發表文章標題為“The effect of supplier relationship management (SRM) practices on exchange cost when going green”。該文章是以台灣的高科技產業為背景，以問卷方式收集實務資料，並進行分析及驗證。在該會議中，本人也與與會的其他學者針對該主題有熱切討論，並交換聯絡方式，獲益良多。

二、 與會心得

這次主辦單位除了安排文章報告與討論，同時也安排了幾場特定主題的座談活動，例如 Operations Management and the Performing Arts, Teaching Service Operations Management, Meet the Editors: Reviewing for Our Top Journals. 這些座談的安排目的，都是為了讓與會者能夠從中得到與自己專業領域相關的新知 – 不論是學術界或產業界，能夠在研討會結束之後得到更多應證及實做的機會。

本人對於其中一項參與的座談“Meet the Editors: Reviewing for Our Top Journals”印象特別深刻。在這個場次中，大會邀請了五大 OM 領域著名雜誌的主編或是領域主編，向與會人士說明期刊接受文章的標準，以及目前期刊的走向等資訊。這些參與的期刊及主編包括：JSCM 的 Robert Klassen, JOM 的 Kan Boyer, IJOPM 的 Steve Brown, 以及 IJPE 的 Bartholomew MacCarthy 等。由於這些雜誌也是本人在學術領域常常翻找資料的來源，同時在選擇研究成果的發表期刊時會考慮的對象，因此對於這些主編所提供的資訊特別感興趣。

這些主編給在場的所有聽眾一些引導，如何正確地審查相關論文，並給予適當的評價。他們提到，幾乎每一本期刊，都會面臨百分之六十到七十的 Desk Reject Rate。而能夠通過第一輪審查的文章，往往也不到百分之三十。這些都考驗著研究者在進行研究的嚴謹及毅力。而何謂一篇好的文章？主編們提到，研究問題要明確，方法描述要清楚，理論發展的邏輯要有條理，而最後結果的論述也應簡潔。重要的是，研究對於文獻及實務界的貢獻為何，也應說明清楚。這些說明對於目前正在投稿階段的本人而言，幫助十分地大。一方面，本人自省自己的文章是否滿足主編們所提出的要求，另外一方面，也瞭解到文章發表的路途是很艱辛的。而也唯有透過這樣反覆的過程，才能讓自己的研究成果達到更精進的目標。

透過本次研討會的進行，本人也更深刻地了解在 OM 領域近年來以及未來的可能發展趨勢，這樣的認知對於未來研究方向的確定也至為重要。根據與會學者的討論，供應鏈與環境保護相關議題的結合，會是下一個研究的發展重心，這從與會人士發表的文章中可以見出端倪。由於本人的研究主題即為“綠色供應鏈管理 (Green Supply Chain Management)”相關，因此透過這次的研討會，本人也與多位學者有相關的討論。這對本人在研究上的幫助很大。

藉著參加本次研討會，本人也與博士求學期間的指導教授 (Damien Power) 再次碰面，彼此之間的友好關係也藉此再度維繫住。本人的指導教授對本人目前的研究領域及進度非常關心，並且表示台灣在全球供應鏈的發展中扮演著舉足輕重的重要性。因此，日後若有合作專案，本人的指導教授會很樂意有參與的機會。

三、 建議

在本次會議的參與過程中，本人發現，台灣地區參加該研討會的人數明顯少於其他國家人數。(除本人外，僅有另兩位分別來自雲林科技大學以及真理大學的學者參與並發表文章。然而來自亞洲區如中國大陸、香港、新加坡、以及泰國地區等學者皆不在少數。) 本人相信台灣學者的研究能力絕對不差，但或許是對歐洲地區研討會的陌生，導致參與意願較低。本人認為，EurOMA 是歐洲地區最大的 OM 領域學會，許多 OM 領域知名學者皆是該學會的

重要會員，並且每年固定參加該學會與新進學者進行討論，若台灣地區相關領域學者也能積極參與該學會每年固定舉辦的研討會，除了可讓歐洲地區認識台灣學者的研究實力，同時也能藉此多認識該領域的知名學者，相信對於日後研究能力的提升也將有所助益。

四、 攜回資料名稱及內容

研討會論文集隨身碟 (Operations Management at the Heart of the Recovery)。

國科會補助計畫衍生研發成果推廣資料表

日期:2014/01/14

國科會補助計畫	計畫名稱: 服務導向供應鏈中不確定性與企業策略及績效之實證探討
	計畫主持人: 羅明琇
	計畫編號: 100-2410-H-004-012-MY2 學門領域: 生產及作業管理
無研發成果推廣資料	

100 年度專題研究計畫研究成果彙整表

計畫主持人：羅明琇		計畫編號：100-2410-H-004-012-MY2				計畫名稱：服務導向供應鏈中不確定性與企業策略及績效之實證探討	
成果項目		量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）	
		實際已達成數（被接受或已發表）	預期總達成數（含實際已達成數）	本計畫實際貢獻百分比			
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	2	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

<p>其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)</p>	<p>無</p>
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	成果項目	量化	名稱或內容性質簡述
科 教 處 計 畫 加 填 項 目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與(閱聽)人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

達成目標

未達成目標（請說明，以 100 字為限）

實驗失敗

因故實驗中斷

其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文： 已發表 未發表之文稿 撰寫中 無

專利： 已獲得 申請中 無

技轉： 已技轉 洽談中 無

其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

根據統計，台灣地區在 2006 年時，全國工商產業登記之企業家數中，約有將近 88 萬家為服務業，並提供全國約 56.95% 的就業機會（同年度製造業約為 14 萬餘家，提供約 35.86% 的就業機會）。從這些數字中不難發現，服務產業在經濟體系中所扮演的角色日益加重。為了在今日競爭激烈的商業環境中維持領先的地位，對提供服務為主的企業而言，在營運過程中無不希冀能確實了解客戶需求，滿足客戶期待，以提升客戶滿意度及忠誠度。本研究透過實務資料的收集，了解服務導向供應鏈中，環境不確定性如何對企業之供應鏈策略造成影響，以及兩者之間的適配性是否將反應在企業績效上。具體而言，本研究探討由顧客端所引起的變異是否可反映服務導向供應鏈中的需求不確定，以及企業所提供之服務流程，其複雜度及多樣性是否可反映供應鏈中的供給不確定性。此外，本研究也探討服務導向供應鏈中供給不確定性與需求不確定性與供應鏈策略之間的關係，以及供應鏈策略與企業績效之間的相關性。

從學術角度而言，本研究延伸了文獻中有關服務導向供應鏈的相關討論，也擴增了權變理論在供應鏈管理領域的應用。對實務領域而言，本研究提供了理論基礎，輔以實證研究資料，供業界人士了解企業所處外部環境因素如何對服務策略與績效造成影響。此研究結果可做為相關企業在訂定服務策略及改善績效時之參考依據。