Decision Support Systems 52 (2012) 474–485

Contents lists available at SciVerse ScienceDirect

Decision Support Systems

journal homepage: www.elsevier.com/locate/dss

Using the balanced scorecard in assessing the performance of e-SCM diffusion: A multi-stage perspective

Ing-Long Wu [a,*], Ching-Hui Chang [b]

[a] Dept. of Information Management, National Chung Cheng University, Taiwan
[b] IT Service Division, Chang Gung Memorial Hospital, Taiwan

ARTICLE INFO

Article history:
Received 8 April 2011
Received in revised form 10 September 2011
Accepted 6 October 2011
Available online 13 October 2011

Keywords:
E-supply chain management
Inter-organizational systems
Innovation diffusion theory
Balanced scorecard
Organizational performance

ABSTRACT

Electronic supply chain management (e-SCM), a specific form of inter-organizational systems, has generally regarded as one of the major strategies to create competitive advantage. The diffusion of e-SCM among trading partners is critical for its final successful use and accordingly, performance impact. However, the diffusion process is complex and dynamic in nature and involves an evolutionary property across time. Innovation diffusion theory (IDT) is defined for effectively exploring diffusion process with multiple stages. Moreover, prior studies have found inconclusive results of IT-enabled performance due to inadequate measures. The balanced scorecard (BSC) with the extension to SCM, incorporating four performance perspectives, is appropriate for overcoming this problem. Grounding on the IDT and BSC, this study proposes a novel framework for exploring the relationships between a stage-based structure and the BSC. Data are collected from a questionnaire survey. The results indicate that there are significant differences between external diffusion and the two earlier stages, adoption and internal diffusion, on the four BSC perspectives. Furthermore, all of the four perspectives are well realized at external diffusion stage. Implications for managers and scholars are discussed.

1. Introduction

Business organizations face a more complex and competitive environment than ever before in the Internet era. Many organizations are gradually considering the importance that they must compete, as part of a supply chain against other supply chains, to quickly reflect the customers' changing demands. Supply chain management (SCM) is an important discipline that enables business partners to integrate their products/services effectively and to build a long-term relationship eventually [24]. SCM can be extensively defined as effective coordinations on material, product, delivery, payment, and information flows between enterprises and trading partners [68,74]. Therefore, SCM discipline is complex and dynamic while involving various work flows across inter-organizational boundaries. The support of information technology (IT), in particular, the Internet and communication technologies, is therefore imperative for making SCM practice feasible [41,81,82]. Electronic SCM (e-SCM) is defined as the physical implementation of SCM process with a support of IT while also attempting to make a distinction from the concept of SCM.

However, e-SCM, although still considered to be in its earlier stage and with a high reported failure rate, is nonetheless believed to be the key to the final success of SCM process [55]. The issue of e-SCM diffusion between partners is complex and dynamic in nature and involves an evolutionary property across time. Previous research has discussed a single decision of adoption in the innovation based on relevant theories, such as technology acceptance model (TAM) [7,11], theory of planned behavior (TPB) [76,80], and their many extensions [75,79]. In contrast, innovation diffusion theory (IDT) is a theory to understand the diffusion of innovations across time [65]. According to the IDT, researchers have presented many models concerning information system (IS) innovation. These models were often addressed as a stage-based process, such as initiation, adoption, and implementation stages [21,22,61]. Specifically, some studies have empirically examined the diffusion of inter-organizational systems (IOS), such as electronic data interchange (EDI), supply chain technology, and e-business, using a stage-based analysis [63,64,85]. An example defines a three-stage structure, adoption, internal integration, external integration, in a diffusion of EDI among small organizations [29].

Therefore, a stage-based analysis may further capture the changes of various diffusion stages in e-SCM implementation over time. Next, as e-SCM increasingly becomes popular, it is necessary to systematically examine its performance impact on the organization [56,57]. The stage-based analysis can provide different degrees of performance impacts on different diffusion stages in a dynamic manner [63,64]. However, little research on deploying IOS has discussed the performance impact in a diffusion perspective among partners. Most studies have focused on the perspective of adoption behaviors, such as intention to use or actual use, across different diffusion stages [21,73]. The enabling role of e-SCM diffusion in organizational

* Corresponding author at: Department of Information Management, National Chung Cheng University, 168 University Road, Ming-Hsiung, Chia-Yi, Taiwan. Tel.: +886 5 2720411x34620; fax: +886 5 2721501.
E-mail address: ilwu@mis.ccu.edu.tw (I.-L. Wu).

0167-9236/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.dss.2011.10.008

performance has not received sufficient attention. Thus, an understanding of the linkage between e-SCM diffusion and organizational performance is our major goal in this study.

Traditionally, most organizations have evaluated performance based largely on financial accounting methods. These methods are important in assessing whether operational changes are improving the financial health of a company, but insufficient to measure supply chain performance. These measures do not relate to important organizational strategies and non-financial performances, such as customer service and product quality [2,42,65]. In addition, prior studies have found inconclusive results of IT productivity despite massive IT investments, namely IT productivity paradox [14,77]. A major reason may be due to the use of inappropriate measures in assessing IT values and has historically focused on financial ones, such as sales and profits [13]. Therefore, researchers suggested the need using more non-financial measures, such as customer satisfaction and product quality, although there is little agreement on precisely which measures to use [5,13]. This implies that the evaluation of e-SCM should cover both quantitative and qualitative measures in a complementary manner.

The Balanced Scorecard (BSC) was initially developed by Kaplan and Norton [31]. The BSC proposes a balanced approach between financial and non-financial measures and specifically looks at a business from four perspectives: finance, customer, internal process, and learning and growth [32,33]. It has been widely applied in assessing organization-based performance in an internal basis in different industries. However, there are few studies in discussing its potential applications to evaluate SCM performance in an external basis [5,53]. One study suggested that the BSC can be extended to include inter-organizational process perspective in supply chain context [53]. That is, internal process has been generally redefined as business process for including both internal and external processes. Grounding on the IDT and BSC, this study thus proposes a new research model for using the extension-based BSC to assess the performance of e-SCM from a multi-stage diffusion perspective. Specifically, a three-stage structure, adoption, internal diffusion, and external diffusion, is defined based on a comprehensive literature review in e-SCM diffusion. In addition, many studies on the issue of adopting supply chain systems have suggested a moderating effect of some organizational characteristics, such as industry type and firm size, on the realization of firm performance [27,62,72]. We thus specified industry type and firm size as two moderating variables.

2. Literature review and hypotheses development

Based on the above discussion, Fig. 1 provides a pictorial depiction of this research framework. The following paragraphs discuss the theoretical foundation of this framework and development of hypotheses.

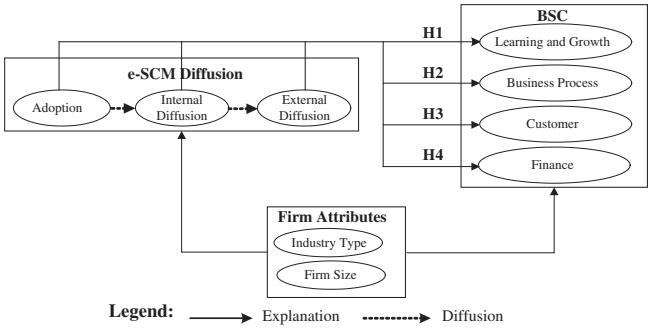

Fig. 1. Research framework.

2.1. SCM and e-SCM

In the contemporary business, SCM is one of the major strategies to enhance organizational efficiency and effectiveness, and ultimately achieve competitive advantages [24,78]. Moreover, the development of business-to-business (B2B) commerce has spotlighted the role of SCM in the modern digital economy [30]. The definition of SCM is developed and used by The Global Supply Chain Forum (GSCF) as "… the integration of key business processes from end users through original suppliers that provide products, services, and information that thus add values for customers and other stakeholders" [40]. The mechanism, in essence, widely covers the activities of integration in an intra-organizational basis and collaboration across inter-organizational boundary [59,71,73]. The ultimate goal of SCM is to build strategic relationships with customers, suppliers, and other business partners [50,54].

In general, there are three components flowing through the supply chain: goods, payments, and information [60]. The movement of the three components needs large amount of information exchange and generally requires frequent communication and collaboration among trading partners. Recently, a growth in information and communication technologies (ICT) such as the Internet-based technologies enhances the capabilities to integrate the supply chain [24,72]. Without the support of ICT, the objective of SCM will not be effectively accomplished [55,62]. Traditionally, inter-organizational systems (IOS) provide an electronic linkage infrastructure to facilitate the movement of the three components in the supply chain with the support of EDI [43,71]. Similarly, electronic SCM (e-SCM) is a specific form of inter-organizational systems with the support of the Internet and e-commerce technologies. More recently, the concept of virtual enterprise (VE) for integrating trading partners through the Internet-based is an important approach to carry out strategic relationship [24].

2.2. IDT and e-SCM diffusion

Effective diffusion of IS innovation is the critical force in determining final success of IS implementation [22,65]. In fact, this process is complex and dynamic in nature, which may vary with distinct sets of characteristics across time and involves different loci of organizational impact [61]. To better understand IS implementation problems and how they can be solved, a multiple-stage rather than a single-stage analysis would provide deep insight for understanding this process [21]. While the IDT is mainly defined for exploring how diffusion of innovation with multiple stages is guided and affected by changes in related variables over time, a stage-based process is originally proposed to include two stages: adoption and implementation [66,67]. The adoption stage further defines sub-stages of knowledge acquisition, persuasion and learning, and decision, leading to the actual adoption decision. The implementation stage further comprises activities of preparation of changes to task structure, task process, and technology necessary for innovation deployment.

While IS innovation has increasingly become an important resource in a firm, the IDT has been widely applied for effectively understanding its diffusion. Kwon and Zmud [39] first generally discussed a six-stage model for IS innovation diffusion, founded on Lewin's three-stage change model [44], including initiation, adoption, adaptation, acceptance, routinization, and infusion. Afterwards, various stage-based models have been proposed for different IS innovations. A four-stage model, comprehension, adoption, implementation, and assimilation, was developed to explore a firm's involvement in IT innovation diffusion [74]. There are a number of three-stage structures presented for the diffusion of IS innovation. A model with the stages of initiation, adoption, and implementation was proposed to understand the use of telecommunications technologies in business organizations [22]. Additional model with the stages of earliness of adoption,

routinization, and infusion was developed to measure the diffusion of electronic scanners in supermarket chains [86]. Recently, Zhu et al. [85] developed a model, initiation, adoption, and routinization, to examine the diffusion of e-business innovation in different countries. Finally, one study has examined a two-stage model, adoption and infusion, to find out the interaction of task and technology factors on MRP implementation [10].

These studies generally view IS innovation diffusion as an internal permeation process extending from initial adoption to full infusion within the firm [17,21]. However, a broader notion of the diffusion process has been noted in some studies on IOS setting such as EDI or SCM innovation. A four-stage model was selected to capture various aspects of EDI diffusion, including adaptation, internal diffusion, external diffusion, and implementation success [58]. There are a number of three-stage models discussed in IOS diffusion. One study indicated three sequential types of implementation outcomes for the decision of adopting EDI, adaptation, internal diffusion, and external connectivity [57]. Another research examined EDI diffusion in small organizations with three stages, adoption, internal integration and external integration [29]. Additional study discussed EDI adoption in the transportation industry in terms of three stages, adaptation, internal diffusion, and external diffusion [59]. Finally, few diffusion models were also discussed in a two-stage structure. One study intended to examine the relationships between the determinants of EDI diffusion and organizational performance with two diffusion stages as mediating variables, internal integration and external integration [64]. Another model has worked in a similar relationship structure with two diffusion stages as mediating variables for understanding the diffusion of web technologies in SCM, internal assimilation and external diffusion [65]. Table 1 presents a summary for the particular diffusion models in IOS setting.

Lewin [44], in general, proposed a three-stage change model, unfreezing, moving, and refreezing, to describe the phenomenon of a system implementing organizational innovation. Next, the present paper is focused on the SCM process, which involves a range of intra-organizational activities and a complicated inter-organizational processes that stretch across trading partners. It needs to treat both internal diffusion and external diffusion processes. Moreover, getting support from the investment of e-SCM or its adoption decision is an important antecedent to the further physical e-SCM diffusion [58]. This is also consistent of the general concept of IDT with adoption and implementation stages [67]. Moreover, in line with the change model and most of the earlier studies with a three-stage structure on IOS setting, this study thus considers a three-stage structure to examine e-SCM diffusion, adoption, internal diffusion, and external diffusion. The following operationally defines the three diffusion stages. Adoption is defined as the extent to which a decision requires being made for the use of e-SCM and a preparation needs to be initiated for the redesign of business process. Internal diffusion refers to the extent to which e-SCM is used to support key internal organizational activities of the firm. External diffusion indicates the extent to which the firm has integrated its trading partners by e-SCM to perform transactions with them.

Table 1
Summary of the stage-based models.

Model	Name of stage	Literature
Two-stage model	Internal integration, external integration	[64]
	Internal assimilation, external diffusion	[65]
Three-stage model	Adaptation, internal diffusion, external connectivity	[57]
	Adoption, internal integration, external integration	[29]
	Adaptation, internal diffusion, external diffusion	[59]
Four-stage model	Adaptation, internal diffusion, external diffusion, implementation success	[58]

2.3. BSC concept

The balanced scorecard (BSC) was initially developed by Kaplan and Norton [31] after an extensive research in early 1990. They argued that traditional financial accounting measures like return-on-investment and earning-per-share offered an incomplete picture of business performance and could give misleading signals for continuous improvement and innovation. Therefore, they claimed that performance evaluation criteria should include non-financial perspectives, such as customer, internal process, and learning and growth. Fig. 2 presents a cyclically influential structure among the four perspectives [31].

While providing executives' information from the four different perspectives, the BSC considers various organizational practices and simultaneously minimizes information overload by limiting the number of measures used. Earlier experience using the scorecard has demonstrated that it meets several managerial needs. First, the scorecard brings together many of the seemingly disparate elements of a company's competitive agenda, such as customer focus, response time, product quality, work process, and new product cycle time, in a single management report. Second, the scorecard guards against sub-optimization. By forcing executives to consider all important performance measures together, the scorecard lets them see whether the improvement in one area may have been achieved at the expense of another. The BSC has been widely applied in many service industries, such as banking [3] and hotel [12], in various business activities, such as customer relationship management [38] and supply chain management [4].

After the initial experience in the early time, many companies have moved beyond their early vision for using the scorecard as a strategic management system. The scorecard in originality addresses a serious deficiency in reflecting a firm's strategy: inability to link a firm's long-term strategy with its short-term actions. Without a comprehensive understanding of a firm's strategy, the executives cannot create alignment with the four perspectives in the scorecard. The scorecard further provides a new framework for organizing strategic objectives into the four perspectives with cause-and-effect relationships, as indicated in Fig. 3 [34–36]. For example, financial perspective comprises three strategic objectives, profitability, revenue growth, and cost structure. This framework defines a hierarchical structure with financial perspective at the top and learning and growth perspective at the bottom. Given that achieving financial success may not be the primary objective of many organizations such as non-profit organizations, they redefined the order of the hierarchical structure with customer perspectives at the top and financial perspective at the next.

2.4. E-SCM diffusion and performance impact

Recent research has pointed out that system adoption is an important determinant to explain the value generated from IT [13,14].

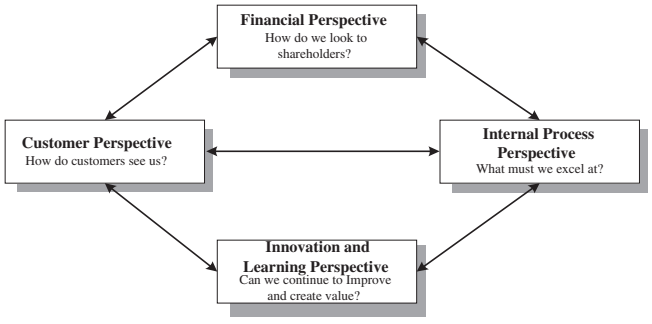

Fig. 2. The balanced scorecard.
Adapted from Kaplan and Norton [31].

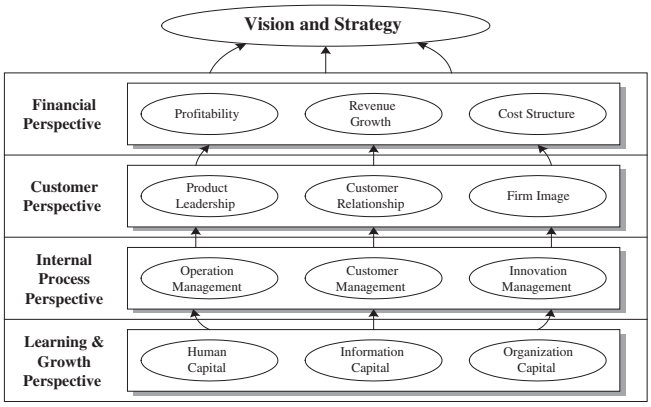

Fig. 3. Strategic structure of the BSC.
Adapted from Kaplan and Norton [35,36].

Specifically, few studies have identified significant performance impacts due to the diffusion of web or EDI-based supply chain technologies with different stages, such as internal and external integration [63,64]. These diffusion stages are in a position to indicate different degrees of performance impacts in supply chain technologies. The idea behind the linkage to performance impact lies in the fact that the diffusion can promote the participation of supply chain partners in inter-firm collaborations and transactions and enhance the digitally enabled integration across their participants through information sharing [65]. Consistent with these ideas, the present research intends to investigate the linkage between e-SCM diffusion and the benefits realized from this diffusion. The following defines performance impacts for supply chain practice.

Performance measures provide the means by which a company can be assessed to find out whether its supply chain has improved or degraded. Traditionally, organizations have evaluated their performance based largely on financial accounting methods that are important in assessing whether operational changes are improving the financial health of a company. However, these measures are insufficient to measure supply chain performance for the following reasons [42,45]. First, they tend to be historically oriented and do not focus on providing a forward-looking perspective. Next, they may not relate to important strategies and non-financial performances, such as customer services, customer loyalty, and product quality [16]. Finally, they may not directly tie to operational effectiveness and efficiency. Moreover, previous studies have attempted to understand the benefits realized from IT investment, but found little or no improvement in the IT payoff, namely IT productivity paradox [14]. This problem may be due to applying inappropriate approach to measure performance, such as financial measures.

Accordingly, some studies for measuring SCM performance have included both financial and non-financial attributes. For example, Beamon [2] proposed a supply chain measurement system that emphasizes three separate types of performance measures, resource, output, and flexibility. Resource is defined as efficient resource management in a system to meet system's objectives, such as manufacturing cost, inventory cost, and return on investment. Output is used to measure customer responsiveness, on-time delivery, and product quality. Flexibility can measure a system's ability to accommodate volume and schedule fluctuations from suppliers, manufacturers, and customers. In sum, resource can be considered as financial performance and output and flexibility as non-financial performance. Besides, Brewer and Speh [4] used the BSC to measure supply chain performance, which intends to link the SCM framework to the four perspectives of the BSC. The SCM framework is defined to comprise four perspectives, company goals, customer benefits, financial benefits, and supply chain improvement.

Next, Park et al. [53] also indicated that most studies simply propose a common framework for supply chain measures, with the need for a more balanced perspective between financial and non-financial attributes. Therefore, they proposed a BSC-based framework in the domain of SCM, namely, the balanced supply chain scorecard (BSCS). In the BSCS, the major difference with the BSC lies in the design of internal process. The traditional BSC mainly emphasizes internal process perspective. However, the major work of SCM intends to perform communication and collaboration efforts among trading partners. External process is very important for achieving the efforts. This study thus extends the scope of the BSC to include the consideration of external process which is defined to comprise three objectives, sourcing leadership, collaboration, and order processing. Accordingly, internal process in the BSC is redefined as a more general term, namely, business process. In addition, customer management objective in internal process perspective is relocated under customer relationship objective in customer perspective. Operation management objective in internal process perspective may be too broad in its definition and further, can be divided into two more specific objectives, manufacturing management and delivery management objectives.

Based on the strategic structure of the BSC in Fig. 3 and the extension of the BSC for the domain of SCM, we developed the measuring items of the four perspectives to assess the performance of e-SCM diffusion. First, we defined objectives/sub-constructs for each of the four perspectives/constructs. Financial perspective includes profitability, revenue growth, and cost structure. Customer perspective comprises product leadership, customer relationship, and firm image. Business process perspective consists of internal process and external process and further the former process includes manufacturing management, delivery management, and innovation management and the latter process includes sourcing leadership, collaboration, and order processing. Learning and growth perspective contains human capital, information capital, and organizational capital. Second, this study further defined the measuring items of these objectives from a comprehensive literature view, as indicated in Table 2.

2.5. Hypotheses development

The following discusses the theoretical foundations of the whole research framework and development of individual hypothesis. First, some studies have particularly examined the differences of the performance impacts of EDI or web technologies on SCM practice across different diffusion stages, such as internal assimilation and external diffusion [64,65]. However, the measures of performance impact may be defined in a single basis or an incomplete manner, such as overall benefits or a combination of operational and market performances. Next, one study found that the Internet-based supply chain integration with a two-stage structure, upstream suppliers and downstream customers, can effectively improve firm performance [20]. Accordingly, the overall theoretical framework is supported in its structure.

Next, to achieve e-SCM diffusion successfully, the work process needs to be redesigned in host organizations as well as their trading partners. In order to do that, employees need to improve their capabilities from organizational learning mechanisms in the area of SCM [37,57]. The objective of knowledge management (KM), in general, mainly intends to be an effective way to improve organizational learning and growth for eventually building a formal learning organization [67,84]. In essence, implementing KM is an important type of IT applications. Moreover, KM implementation is basically a general term in this definition while it may be associated with different application domains, such as marketing or SCM. In this study, learning and growth capabilities may be particularly improved from KM implementation with SCM domain. Next, the implementation of e-SCM has been usually defined as a multi-stage diffusion process in the literature, as discussed above. Accordingly, we can argue that different

Table 2
Measures of the BSC.

Perspectives	Objectives	Measures	SCM sources
Financial perspective	Profitability	Increase return on investment	[2,45,81]
		Increase return assets	[2,5,25,42]
		Increase profit margin	[15,83]
	Revenue growth	Increase sales revenue	[2,42]
		Increase market share	[2,5,45]
	Cost structure	Improve operating efficiency	[2,42,49]
		Improve asset utilization	[25,42]
Customer perspective	Product leadership	Improve quality of products	[25,70]
		Provide wide range of products	[25]
		Reduce return rate of products	[49]
	Customer relationship	Reduce customer response time	[2,5,18]
		Improve on-time delivery	[2,49]
		Improve customer order fill rate	[18,42]
	Firm Image	Increase corporate image and reputation	[15]
		Increase recognition rate of corporate brand	[23,83]
Business process perspective	Manufacturing management	Improve production quality	[42,53]
		Increase production efficiency	[25,42]
		Improve inventory accuracy	[2,53]
	Delivery management	Increase delivery efficiency	[25,42]
		Improve transportation tool utilization	[42]
	Innovation management	Commercialize innovative product quickly	[47,49,69]
		Identify more market innovative opportunities	[47,83]
	Sourcing leadership	Improve quality of purchased goods	[25]
		Reduce price of purchased goods	[42]
		Improve supplier online delivery	[25,42]
	Collaboration	Improve order information sharing	[4]
		Improve inventory information sharing	[4]
		Improve forecast information sharing	[18,42]
	Purchase order processing	Improve purchase order fill rate	[18]
		Improve percentage of online purchase order	[54,55]
Learning and growth perspective	Human capital	Improve employees skills	[15,46]
		Improve know-how capabilities of employees	[35,36]
	Information capital	Improve capabilities of knowledge management	[35,36]
		Improve accessibility of various information	[35,36]
	Organizational capital	Improve sharing of worker knowledge	[35,36]
		Improve awareness of vision, objectives, and	[35,36]

diffusion stages of e-SCM may indicate differentiated effects on learning and growth perspective. Hypothesis 1 is thus proposed.

Hypothesis 1. The diffusion of e-SCM's adoption, internal diffusion, and external diffusion is positively related to learning and growth performance.

Before heavy investment in IT, companies should redesign their business process, such as job design and work flow, in order to greatly achieve improvement in their performance from investing IT [26]. Thus, while an organization reaches the decision to deploy e-SCM, it would initiate to change its business process before implementing e-SCM. Specifically, researchers found that diffusing web-based supply chain in two stages, internal assimilation and external diffusion, has resulted in differentiated improvements in the processes of inventory management, product cycle-time, and supplier-relationship management [65]. Therefore, different diffusion stages of e-SCM may indicate differentiated effects on business process perspective. Hypothesis 2 is proposed.

Hypothesis 2. The diffusion of e-SCM's adoption, internal diffusion, and external diffusion is positively related to business process performance.

Customer perspective is also recognized as an important dimension of firm performance. In the supply chain, the use of the Internet-based technologies among trading partners could effectively reduce customer response time and provide a high level of customer service [41]. Many studies found that the firms with an integration of EDI from both internally with their functions and externally with their partners can enjoy greater benefits in terms of the improvement in customer service and attraction of new customers [57,64]. Additional study reported that diffusion of web-based supply chain with two stages, internal assimilation and external diffusion, can impose significantly differentiated improvements in customer service [65]. Based on these arguments, we can assume that different diffusion stages of e-SCM may produce differentiated effects on customer perspective. Thus, Hypothesis 3 is proposed.

Hypothesis 3. The diffusion of e-SCM's adoption, internal diffusion, and external diffusion is positively related to customer performance.

Research on EDI or web-based supply chain has identified significant financial impact [62,63]. One study revealed the relationships between the diffusion of EDI with adoption and integration stages and its impact on financial-based performance such as reduced transaction cost and inventory level [29]. Ramamurthy et al. [64] found that two stages in EDI diffusion, internal integration and external integration, can effectively facilitate the improvement of operational performance. They indicated clearly that the firms in their study have realized greater operational benefits in the forms of reduced operational costs and improved productivity. Accordingly, we argue that different diffusion stages of e-SCM indicate differentiated effects on financial perspective. Hypothesis 4 is thus proposed.

Hypothesis 4. The diffusion of e-SCM's adoption, internal diffusion, and external diffusion is positively related to financial performance.

2.6. Moderating variables

Many studies have argued that some organizational characteristics, such as industry type and firm size, have potential impact on adoption or diffusion of supply chain based technologies [27,72].

The firms in high dynamic industries, such as electronics and high-tech manufacturing, show higher revenue volatility and customer turnover while compared to those in low dynamic industries [48]. Researchers thus suggested that industry type may play a moderating role in the achievement of SCM process [51,62]. In addition, larger firms are more likely to implement SCM practice than smaller firms because they possess the resources and capabilities necessary to assimilate the innovation effectively. Thus, firm size was found to have a positive impact on adoption behavior toward the innovation. It should be incorporated in the relationship structure for moderating some extraneous effects [51,72].

3. Research design

A survey study was conducted to collect empirical data. The design of research is described as below.

3.1. Instrumentation

The survey instrument contains a three-part questionnaire, as indicated in Appendix A. The first part uses a nominal scale, and the rest use 7-point Likert scales.

3.1.1. Basic information

This part collects the information about organizational and respondent's characteristics. The former includes industry type, annual revenue, number of employees, and number of supplies. The latter includes working experience, education level, and position.

3.1.2. e-SCM innovation diffusion

This part measures the extent of the three stages in diffusing e-SCM, adoption, internal diffusion, and external diffusion. The items for measuring adoption stage were defined by the support from e-SCM in the key organizational activities of SCM practice [6,85]. These activities include logistics, productions/operations, sale revenue, market share, and coordination. As a result, there are 5 items in this part. Next, some studies discussed the measures of internal diffusion stage by which various functions in a firm have adopted various supply chain technologies [54,55]. Other studies also indicated the similar definition in measuring EDI [63,64]. The measuring items for this stage were thus adapted from these studies, including various IT-supported tools in accounting, delivery, warehousing and inventory, productions/operations, and order processing management. As a result, there are 5 items in this part. Finally, the items for measuring external diffusion stage were adapted from the scale developed by Ranganathan et al. [65]. They were defined by the extent to which trading partners have interacted with e-SCM in three different aspects, that is, proportion of total suppliers interacting with firm through e-SCM, proportion of total transactions with suppliers done through e-SCM, and proportion of total interactions with suppliers done through e-SCM. As a result, there are 3 items in this part.

3.1.3. Organizational performance

This part measures the four performance perspectives of the BSC, that is, finance, customer, business process, and learning and growth. The four perspectives first identify their objectives/sub-constructs and then develop their measuring items from an extensive literature review, as indicated in Table 2. As a result, the financial, customer, business process, and learning and growth constructs comprise 7 items, 8 items, 17 items, and 6 items, respectively.

3.1.4. Moderating variable

Industry type was defined to include three types of industries, that is, high-tech manufacturing, traditional manufacturing, and service. Firm size was measured using the total number of employees in a firm. It consists of three types of firm sizes, that is, large size, medium size, and small size.

3.2. Sample organizations and respondents

This study primarily explores the performance impact of e-SCM diffusion in organizations. The qualified firms for this study require an emphasis on investments in supply chain technologies and have considerable experience in SCM practice. Thus, it is assumed that larger firms would be more likely to have these experiences. A sample frame was assembled from the 2009 listing of manufacturing and service firms published by the Taiwan Stock Exchange Corporation, which contains 1000 manufacturing and 500 service firms. Furthermore, 600 manufacturing and 250 service firms were randomly selected as the study sample from this source. The target respondents for this survey would be the top managers, including general managers, vice general managers, or logistics/purchase executives in SCM division. These people are more likely familiar with the issue of e-SCM and its performance impact. The names and addresses of the top managers for the firms have been made publicly on their web sites. A survey method was used for this study. This survey was conducted during the period of April–June in 2009. First, the questionnaire with a returned envelope was mailed to one of the top managers for each firm, and accordingly, each firm only received one questionnaire. Furthermore, in order to improve survey return, follow-up procedure was carried out by mailing reminders for non-respondents after 2–3 weeks.

3.3. Scale validation

Initially, pretest was conducted for the scale. The scale was carefully examined by selected practitioners and academicians in this area, including translation, wording, structure, and content. Content validity of the scale should be in an acceptable level. After the questionnaire was finalized, 850 questionnaires were successfully sent out for the potential respondents. 191 questionnaires were responded. After invalid responses deleted, this resulted in a sample size of 127 for a response rate of 15%. Table 3 depicts the sample demographics. The seemingly low response rate raises concern about non-response bias. We tested the non-response bias for the responded sample. Considering the late group of respondents as most likely to be similar to non-respondents, a comparison between the early and late group of respondents provides information on non-response bias in the sample [1,72]. Accordingly, the early and late sub-samples were identified as 80 and 47 respondents, respectively. The two groups were compared, using various organizational characteristics, for their correlations with *t*-test, including annual revenue, number of employees, and number of suppliers. All their correlations revealed no significant difference at the 0.05 level (t value = 0.58, 0.41, and 0.48). The results indicated no systematic non-response bias for the survey data.

In addition, common method bias results from the fact that the respondents provide the measures of explanatory and dependent variables by a common rater [56]. In this study, subjective measures were used for three diffusion stages as the explanatory variables and four BSC performance measures as the dependent variables. There is a risk for common method bias. Harman's single factor test is one of the most widely techniques to address the issue of common method variance [56]. We included all items from all of the constructs for a factor analysis to determine whether the majority of the variance can be accounted for by one general factor. The results reported the explanatory and dependent variables extracted as different factors from the survey data. No single factor accounts for the bulk of covariance, leading to the conclusion of the inexistence of common method bias.

3.3.1. Measurement model

Partial least square (PLS) is a components-based structural equation modeling (SEM) technique. PLS allows latent variables to be modeled in

Table 3
Demographics.

Characteristics	Frequency	Percent (%)
Industry type		
High-tech manufacturing	33	25.98
Traditional manufacturing	50	39.37
Service	44	34.65
Annual revenue		
<1000 M	25	19.69
1000–10,000 M	44	34.64
10,000–10,0000 M	45	35.43
>10,0000 M	13	10.24
No. of employees		
<1000	75	59.05
1000–5000	30	23.62
5000–10,000	12	9.44
>10,000	10	7.93
No. of suppliers		
<100	63	49.60
100–300	27	21.25
300–500	20	15.74
>500	17	13.41
Working experience		
<5 years	24	2.36
5–10 years	32	25.20
10–20 years	36	14.17
>20 years	24	41.73
Education level		
High school	6	4.72
College	71	55.91
Graduate school	50	39.37
Position		
General managers	24	18.90
Vice general manager	36	28.35
Logistics executives	22	17.32
Financial executives	13	10.23
Others	32	25.20

the conditions of non-normality and small to medium sample size. Theoretically, the sample size for executing PLS requires 10 times of the number of indicators associated with the most complex construct or the largest number of antecedents linking to an endogenous construct [9]. In particular, it can model latent constructs as either formative or reflective constructs in forming their superordinate constructs. Reflective indicators are used to examine an underlying construct which is unobservable such as attitude and intention. Formative indicators are used to form a superordinate construct as a categorization and measurement device for complex phenomena, where the individual indicators are weighted according to their relative importance in forming the construct [8,9]. Moreover, formative indicators need not to be correlated nor need to have high internal consistency. In our research model, each performance perspective is mainly viewed as an explanatory combination of its indicators, for example, profitability, revenue growth, and cost structure indictors for financial construct. Moreover, covariance among indicators for each main construct is not necessary. Therefore, the four performance perspectives should be modeled as formative constructs, which were further determined from a combination of the first-order formative indicators. Accordingly, a second-order measurement model was built to validate the scale and further, PLS was appropriate to be used in analyzing it.

First, internal consistency is assessed using Cronbach's α. A score of 0.7 or higher is acceptable [52]. Second, convergent validity is assessed using three criteria: (1) all item loadings (λ) for each construct larger than 0.70, (2) composite construct reliability for each construct greater than 0.70, (3) average variance extracted (AVE) for each construct larger than 0.50 [19]. AVE is used to assess the variance shared between a construct and its measuring items. Discriminant validity is acceptable when the square root of AVE for a given construct is greater than its correlations with other constructs [28]. Table 4 shows the indices of reliability and convergent validity. The values of Cronbach's α are all larger than 0.7. Item loadings range from 0.71 to 0.94, composite construct reliabilities range from 0.78 to 0.92, and average variances extracted range from 0.60 to 0.79. All constructs and sub-constructs indicate a high degree of reliability and convergent validity. Table 5 reports the indices of discriminant validity. All constructs and sub-constructs meet the criteria of discriminant validity.

4. Hypotheses testing

PLS was used to analyze the structural model which attempting to draw conclusion about the nature of the causal relationships. First, we need to estimate standardized path coefficient and their statistical significance for the influential paths in the research model. However, PLS does not directly provide a significance test or confidence interval estimation of path coefficient in the research model. Bootstrapping analysis was conducted with 1000 subsamples to reestimate path coefficients using each of these samples. Next, coefficient of determination (R^2) for endogenous variables is estimated to assess the predictive power of the research model. Table 6 presents the testing results for the three predictors on the four performance perspectives.

The following describes the results of hypotheses testing. First, we found that the three diffusion stages are all significant in determining learning and growth performance, adoption ($p<0.05$), internal ($p<0.05$), and external diffusion ($p<0.01$) (path coefficient, $\beta = 0.21$, 0.25, and 0.40). Thus, Hypothesis 1 is fully supported.

Table 4
Reliability and convergent validity.

Construct	Mean	S.D.	Item loading	Composite reliability	AVE	Cronbach's α
Adoption (AD)	4.89	1.18	.71–.84	.79	.60	.82
Internal diffusion (ID)	4.88	1.13	.74–.86	.82	.64	.83
External diffusion (ED)	5.27	1.26	.88–.94	.91	.78	.92
Profitability (PR)	4.78	1.23	.90–.94	.92	.72	.91
Revenue growth (RG)	5.31	1.11	.76–.81	.80	.73	.82
Cost structure (CS)	4.77	1.22	.80–.84	.81	.69	.83
Product leadership (PL)	5.08	1.12	.85–.91	.88	.71	.90
Customer relationship (CR)	4.41	1.28	.88–.93	.91	.73	.92
Firm image (FI)	4.52	1.26	.82–.84	.82	.70	.85
Manufacturing management (MM)	4.32	1.12	.78–.81	.78	.66	.83
Delivery management (DM)	4.54	1.12	.81–.83	.81	.79	.82
Innovation management (IM)	4.65	1.13	.78–.81	.80	.68	.82
Sourcing leadership (SL)	4.35	1.01	.81–.83	.82	.75	.84
Collaboration (CO)	5.78	1.21	.83–.85	.85	.61	.88
Purchase order processing (PO)	4.08	0.98	.86–.88	.87	.72	.89
Human capital (HC)	4.58	1.13	.79–.83	.82	.73	.84
Information capital (IC)	5.03	1.21	.82–.86	.84	.68	.88
Organizational capital (OC)	4.87	1.09	.83–.85	.85	.69	.87

Table 5
Discriminant validity.

Construct	AD	ID	ED	PR	RG	CS	PL	CR	FI	MM	DM	IM	SL	CO	PO	HC	IC	OC
AD	.77																	
ID	.11	.80																
ED	.09	.21	.88															
PR	−.03	.15	.26	.84														
RG	.20	.30	.12	.08	.85													
CS	.15	−.09	.08	.13	.12	.83												
PL	.18	.05	.13	.26	.18	.21	.84											
CR	.23	.20	.18	.15	.09	.13	.31	.85										
FI	.08	.11	.25	.18	.31	.08	.21	.15	.83									
MM	−.11	.20	−.09	.31	.15	−.05	.06	.18	.15	.81								
DM	.21	.19	.12	.04	.20	.15	−.11	.09	.20	.21	.88							
IM	.15	.25	.21	.12	.21	.21	.09	.21	.16	.14	.16	.82						
SL	.21	.16	.06	.15	.06	.25	.14	.25	.06	.03	.06	.35	.86					
CO	.31	.26	.17	.29	−.09	.08	.22	.05	.03	.07	.21	.15	.28	.78				
PO	.17	.10	.30	.02	.11	.11	.13	.06	.22	.10	.19	.11	.13	.15	.84			
HC	.05	−.11	.21	−.06	.14	.13	.06	.03	.11	−.06	.05	.03	.05	.19	.21	.85		
IC	.08	.06	.18	.21	.21	.09	−.09	.18	.09	−.08	.23	.09	.11	.05	.16	.11	.82	
OC	.19	.05	.13	.05	.08	.16	.19	−.05	.15	.19	.05	.17	.16	.26	.08	.09	.21	.83

Diagonal value: squared root of AVE, non-diagonal value: correlation.

External diffusion stage has larger effect on this performance than the other two stages. Moreover, the three diffusion stages jointly explain 42% of variance in learning and growth performance. Next, business process performance has been reported with the similar impact pattern from the three diffusion stages, adoption ($p<0.05$), internal diffusion ($p<0.05$), and external diffusion ($p<0.01$) ($\beta = 0.23$, 0.26, and 0.38). Therefore, Hypothesis 2 is fully supported. External diffusion stage also presents larger impact than the other two stages. Moreover, the three diffusion stages jointly explain 43% of variance in business process performance. Third, internal diffusion ($p<0.05$) and external diffusion ($p<0.05$) stages are both important antecedents of customer performance while adoption stage indicates no significance ($\beta = 0.22$ and 0.28 vs. 0.14). Thus, Hypothesis 3 is partially supported. Moreover, the three diffusion stages jointly explain 35% of variance in customer performance. Finally, for finance performance, there is only one stage, external diffusion, indicating a critical role in determining finance performance while the other two stages are not ($\beta = 0.21$ vs. 0.05 and 0.11). Therefore, Hypothesis 3 is partially supported. Moreover, the three diffusion stages jointly explain 31% of variance in finance performance.

In addition, Table 7 shows the results regarding the roles of moderating variables with independent and dependent variables. For independent variables, industry type is positively related with adoption and external diffusion stages while firm size indicates a difference from it with a positive correlation with internal diffusion stage. For dependent variables, industry type is positively correlated with business process performance at adoption stage. Industry type and firm size were found to have positive correlations with customer and finance performance at internal diffusion stage respectively. Finally, industry type is positively associated with finance performance at external diffusion stage.

5. Findings and discussions

This section first discusses the relationship between the three-stage process and the four performance perspectives as a whole, and then the specific findings across the three diffusion stages. In general, there is no significant difference between adoption and internal diffusion stage for the four performance perspectives. Performance differences are only reported significantly between external diffusion stage and the two earlier stages for the four performance perspectives. This indicates that the four performances are well achieved only at external diffusion stage. The reasons behind this may be described as below. In fact, e-SCM is a form of inter-organizational system that integrates it with in-house supply chain applications and with applications of trading partners to perform transactions. For instance, the work practice needs to be changed in the firm's internal processes, such as purchase, production, and marketing, to effectively deploy e-SCM. That is, business processes need to be first redesigned before physically implementing e-SCM. The redesign of business process is important for driving an initial use to further acceptance of the innovation. It usually requires substantial efforts and time. Furthermore, while a firm tries to persuade its business partners to adopt e-SCM, this may be even much more difficult. Therefore, time-lag effect plays a significant role in interfering the performance impact of e-SCM diffusion and further, is able to lead to the full achievement of e-SCM contribution in the latter diffusion stages, such as external diffusion in this study.

Next, many researchers argued that one major reason for inconclusive results of IT performance may come from the use of inappropriate approach in measuring IT values. Traditionally, the performance measures have been focused on financial perspective. In this study, the four performance perspectives of the BSC have shown different views for the achievement of e-SCM deployment across different diffusion stages. Specifically, learning and growth and business process perspectives play a critical role in the performance measures of the earlier stages while customer and financial perspectives place more emphasis

Table 6
Results of the structural model.

	Adoption	Internal diffusion	External diffusion	R^2
Learning and growth	0.21*	0.25*	0.40**	42
Business process	0.23*	0.26*	0.38**	43
Customer	0.14	0.21*	0.28*	35
Finance	0.05	0.11	0.21*	31

* $p<0.05$.
** $p<0.01$.

Table 7
Results of the moderating variables.

	Adoption		Internal diffusion		External diffusion	
	Ind. type	Firm size	Ind. type	Firm size	Ind. type	Firm size
Independent variable						
Diffusion stage	0.22*	0.10	0.11	0.37**	0.25*	0.03
Dependent variable						
Learning and growth	−0.05	0.08	−0.07	0.11	0.08	0.12
Business process	0.32*	0.10	−0.03	−0.17	−0.06	0.11
Customer	−0.13	0.09	0.28*	0.18	0.12	0.14
Finance	−0.07	0.04	−0.08	0.37*	0.29*	−0.06

* $p<0.05$.
** $p<0.01$.

on the performance achievements from the latter stages. The results of this study, regarding the performance impact of e-SCM diffusion, have generally offered the insight of inadequate approach applied in measuring IT values. That is, the finance-based measures may not appropriately reflect the real performance of an organization at the earlier stages and require an extended period of time to realize. This may be because financial performance is often the ultimate goal of most organizations. In short, while IT productivity paradox has often been the major problem on the issue of IT performance measure, this study particularly considers both a stage-based structure and the BSC for understanding the performance impact of e-SCM diffusion. We have concluded that two major determinants, time-lag effect and measurement method, are the major causes of IT productivity paradox.

At the adoption stage, firm performance is primarily reflected on learning and growth and business process perspectives, as compared to customer, and financial perspectives. Thus, learning and growth and business process perspectives can be considered as reliable performance measures at this stage. This may be explained by the facts. The major work of adoption stage focuses on the plan of how a company can be well supported through e-SCM and preparation of restructuring business processes before physically implementing e-SCM. Company's employees need to enhance their competences and skills in order to well perform these activities. Therefore, the results show that learning and growth and business process perspectives are the important indicators of organizational performance at this stage. Besides, many studies have argued that the performance impact of general IT on organizations, such as customer and financial performances, is mainly through the mediator of business process. The objective of IT-supported knowledge management, a special type of IT, focuses on improving learning capabilities for the basis of enabling other forms of organizational performance. Therefore, these two performance perspectives tend to be well performed at the earlier stages of e-SCM diffusion.

At the internal diffusion stage, there are three performance perspectives indicating their significant improvements, that is, learning and growth, business process, and customer. Internal diffusion defines the extent to which e-SCM is used in the key organizational activities in SCM division. This diffusion stage has established a close connection with customers in an effective way in terms of an integration of all internal SCM applications through web-based technologies. Customers intend to get better quality of service in the entire purchase cycle, that is, pre-purchase, purchase, and post-purchase stage. As a result, it indicates a performance improvement in customer perspective in comparison with adoption stage. On the other hand, the literature also argued that some important non-financial performances, such as customer satisfaction or relationship, may require certain periods of time to realize their performance [35,36]. In particular, service-oriented industries may consider customer performance as the final goal of their business. The findings can partially explain the role of time-lag effect in realizing customer performance while considering internal diffusions as being at the latter diffusion stages.

At the external diffusion stage, all of the four dimensions in the BSC are generally considered as reliable indicators of organizational performance, in particular, financial performance. The major work of external diffusion focuses on the use of e-SCM to integrate the firm with its trading partners in an inter-organizational basis. Many studies argued that collaborative use of web-based systems is more likely to improve B2B process in the areas of cost-based performance, customer service, logistics, production efficiency, inventory management, and product cycle-time. Accordingly, financial performance is in a position to be improved significantly. Next, most firms in different industries have regularly considered financial performance as the ultimate goal of their business and it would require much longer time-lag to realize this performance. The other three performance perspectives may play the roles of fundamental or intermediate effect in the final achievement of financial performance. Our finding indicates a consistence with the argument of an influential relationship structure among the four performance perspectives proposed by Kaplan and Norton [35,36]. In addition, this stage has larger effect on learning and growth and business process performances than the other two stages. This can be explained by the fact of time-lag effect. The latter diffusion stages may have longer time of period to fully realize different forms of firm performance.

Finally, a few words about the moderating variables are in order. For the three diffusion stages, industry type mainly reflects its correlation with adoption and external diffusion stage and on the other hand, firm size mainly reflects the correlation with internal diffusion stage. The reasons behind this are as below. Competitive/external pressure is the major driver for the firm to initially make the decision in adopting e-SCM. Furthermore, the extent of e-SCM diffusion within the organization will be affected by firm size in an alternative manner. This is because larger firms are more likely to follow the decision and then diffuse it smoothly. Finally, e-SCM diffusion across trading partners greatly depends on industry type while it determines the form of industry structure. High-tech manufacturing tends to have aggressive culture or beliefs to spread the use of a new innovation as compared to traditional manufacturing. For the four performance perspectives, industry type indicates the correlation role with different forms of performance achievement for all of the three diffusion stages. In contrast, firm size only shows the association role with finance performance at internal diffusion stage. This may indicate that externally based organizational attributes, such as industry type, are more important in controlling performance achievement of e-SCM than internally based organizational attributes, such as firm size.

6. Conclusions and suggestions

More organizations have recognized e-SCM as an important issue of technology innovation and a source of differentiation advantage. Successful use of e-SCM among trading partners is the key to performance realization in host organizations. This study approaches the particular issue from a new consideration of integrating a stage-based diffusion structure and the BSC with different forms of organizational performance. It takes a thorough approach, in contrast to earlier studies, to show the performance realization process for the implementation of e-SCM. Important findings have been reported in this study. The three diffusion stages indicate different impacts on the four performance perspectives. In particular, significant differences have been reported between the final stage (external diffusion) and the two earlier stages (adoption and internal diffusion). Furthermore, the four performance perspectives are well realized at external diffusion stage. First, the issue on e-SCM diffusion has been particularly external focus on the collaboration among trading partners. Time-lag effect is the important determinant for effectively measuring organizational performance, in particular, customer and financial performances. In general, this can also provide insight to IT productivity paradox for effectively designing implementation program of technology innovation. This may be the major contribution of this research.

The findings have a number of implications for practitioners. Practitioners will be able to design appropriate strategies to deal with e-SCM implementation problem due to understanding the performance achievement process with different forms of performance impacts. Next, while the focus of e-SCM diffusion is on the readiness of external activities in the supply chain, partners need to build a well-coordinated mechanism for managing these activities before deploying e-SCM. In addition, time-lag effect is a critical role for distinguishing different forms of organizational performance. In order to fully achieve customer or financial performance, an extended period of time is necessary for e-SCM implementation. The host organization needs to carefully examine the extent of e-SCM diffusion before any decision has to be made in terms of the collaborative effort in achieving SCM performance among trading partners. Finally, as many studies have noted the intermediate role of business

process in IT-enabled performance, practitioners need to first nurture some organizational practices or capabilities, such as learning and growth and business process, in order to eventually reach their financial performance. Therefore, it is important for an organization in terms of the improvement of these organizational capabilities or practices through knowledge management mechanism or other training programs.

Furthermore, future research could be based on this foundation. First, this research model is mainly verified by an empirical survey in this study. Subsequent research could particularly conduct a case study with a longitudinal observation to more deeply understand the usefulness of this framework in practice. Second, since a sample frame of this research was assembled from different industries, its conclusions were more general and comprehensive. Future research could be targeted at a particular industry, such as the service industry, to capture their similarities and differences between the two different research bases. Moreover, this would also provide more insight into e-SCM implementation practice in some particular industries. Finally, the primary goal of this study lies in examining the performance impacts of e-SCM diffusion on four performance perspectives in the BSC. Future research could further explore the influencing relationships among four performance perspectives. This would enable practitioners to effectively distribute their resources on the major drivers of performance achievement.

As already noted, even though this research has provided some useful results, it still has some limitations. First, the response rate is lower than desirable despite making various efforts to improve it. This may be because target respondents may lack relevant experiences in deploying e-SCM diffusion with a multi-stage analysis in practice. However, the responding sample indicated no systematic non-response bias and was well representative of the study sample. Next, the target respondents in each firm were originally designed for general managers, vice general managers, and logistics/purchasing executives in SCM function. However, approximately 25% of the respondents were in the position of staff member. Since senior managers in the larger firms are usually busy, some questionnaires may be completed by their subordinates. In fact, staff members are those people who are physically responsible for the daily work. However, additional benefit would be an increase in the diversity of data sources with multiple informants and therefore, an increase in the variances of the variables of interest.

Appendix A. Questionnaire

Part I. Basic information

1. Industry type_____.
2. Annual revenue (NT$ millions):
   ☐Less than 1000M ☐1000~10000M ☐10000~100000M ☐Greater than 100000M
3. Number of employees (Persons):
   ☐Less than 1000 ☐1000~5000 ☐5000 ☐Greater than 10000
4. Total number of suppliers_____.
5. Working experience:
   ☐Less than 5 years ☐5~10 years ☐ 10~20 years ☐Greater than 20 years
6. Education level: ☐High school ☐College ☐Graduate college ☐Ph. D. ☐Other
7. Gender ☐ Male ☐ Female
8. Age _____.
9. Position _____.

Part II. E-SCM diffusion

1. Adoption

My firm considers using digitally enabled SCM to improve logistics.
My firm considers using digitally enabled SCM to improve productions or operations.
My firm considers using digitally enabled SCM to increase sale revenue.
My firm considers using digitally enabled SCM to increase market share.
My firm considers using digitally enabled SCM to improve coordination with customers and suppliers.

2. Internal diffusion

My firm has used digitally enabled SCM in supportingaccounting management.
My firm has used digitally enabled SCM in supporting product or service delivery management.
My firm has useddigitally enabled SCM in supporting warehousing and inventory management.
My firm has used digitally enabled SCM in supporting productions or operations management.
My firm has useddigitally enabled SCM in supporting order processing management.

3. External diffusion

The proportion to which total suppliers of my firm have interacted with other firms through digitally enabled SCM.
The proportion to which total transactions of my firm with suppliers are done through digitally enabled SCM.
The proportion to which total interactions of my firm with suppliers are done through digitally enabled SCM.

Part III. Organizational performance

This part of measuring items can be referred to Table 2 in terms of financial, customer, business process, and learning and growth perspectives.

References

[1] J. Armstrong, T. Overton, Estimating non-response bias in mail survey, Journal of Marketing Research 14 (3) (1977) 396–402.
[2] B.M. Beamon, Measuring supply chain performance, International Journal of Operations and Production Management 19 (3) (1999) 27–29.
[3] J. Beechey, D. Garlick, Using the balanced scorecard in banking, Journal of the Australian Institute of Bankers 113 (1) (1999) 28–31.
[4] P.C. Brewer, T.W. Speh, Using the balanced scorecard to measure supply chain performance, Journal of Business Logistics 21 (1) (2000) 75–94.
[5] Y.E. Chan, IT value: the great divide between qualitative and quantitative and individual and organizational measures, Journal of Management Information Systems 16 (4) (2000) 225–261.
[6] D. Chatterjee, R. Grewal, V. Sambamurthy, Shaping up for e-commerce: institutional enablers of the organizational assimilation of web technologies, MIS Quarterly 26 (2) (2002) 65–89.
[7] T.C. Cheng, Y.C. Lam, C.L. Yeung, Adoption of internet banking: an empirical study in Hong Kong, Decision Support Systems 42 (2006) 1558–1572.
[8] W.W. Chin, Issues and opinion on structural equation modeling, MIS Quarterly 22 (1) (1998) 7–16.
[9] W.W. Chin, B.L. Marcolin, P.R. Newsted, A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study, Information Systems Research 14 (2) (2003) 189–217.
[10] R.B. Cooper, R.W. Zmud, Information technology implementation research: a technological diffusion approach, Management Science 36 (2) (1990) 123–139.
[11] F.D. Davis, R.P. Bagozzi, P.R. Warshaw, User acceptance of computer technology: a comparison of two theoretical models, Management Science 35 (8) (1989) 982–1003.
[12] G.A. Denton, B. White, Implementing a balanced-scorecard approach to managing hotel operations: the case of white lodging services, The Cornell Hotel and Restaurant Administration Quarterly 41 (1) (2000) 94–107.
[13] S. Devaraj, R. Kohli, Information technology payoff in the health-care industry: a longitudinal study, Journal of Management Information Systems 16 (4) (2000) 41–67.
[14] S. Devaraj, R. Kohli, Performance impacts of information technology: is actual usage the missing link? Management Science 49 (3) (2003) 273–289.
[15] D.A. Ellingson, J.R. Wambsganss, Modifying the approach to planning and evaluation in governmental entities: a balanced scorecard approach, Journal of Public Budgeting Accounting and Financial Management 13 (1) (2001) 103–120.
[16] R.G. Fichman, The role of aggregation in the measurement of IT-related organizational innovation, MIS Quarterly 25 (4) (2001) 427–456.
[17] R.G. Fichman, C.F. Kemerer, The assimilation of software process innovations: an organizational learning perspective, Management Science 43 (10) (1997) 1345–1363.
[18] G. Fliedner, CPFR: an emerging supply chain tool, Industrial Management and Data Systems 103 (1) (2003) 14–21.
[19] C. Fornell, D.F. Larcker, Evaluating structural equation models with unobservable variables and measurement error, Journal of Marketing Research 18 (1) (1981) 39–50.
[20] M.T. Frohlich, R. Westbrook, Demand chain management in manufacturing and services: web-based integration, drivers and performance, Journal of Operations Management 20 (6) (2002) 729–745.
[21] M.J. Gallivan, Organizational adoption and assimilation of complex technological innovations: development and application of a new framework, The Data Base for Advances in Information Systems 32 (3) (2001) 51–85.
[22] V. Grover, M.D. Goslar, The initiation, adoption, and implementation of telecommunications technologies in US organizations, Journal of Management Information Systems 10 (1) (1993) 141–163.
[23] A. Gumbus, B. Lyons, The balanced scorecard at Philips Electronics, Strategic Finance 84 (5) (2002) 45–49.
[24] A. Gunasekaran, E.W.T. Ngai, Information systems in supply chain integration and management, European Journal of Operational Research 159 (2) (2004) 269–295.
[25] A. Gunasekaran, C. Patel, E. Tirtiroglu, Performance measures and metrics in a supply chain environment, International Journal of Operations and Production Management 21 (1/2) (2001) 71–87.
[26] M. Hammer, Reengineering work: don't automate, obliterate, Harvard Business Review 68 (4) (1990) 104–112.
[27] W. Hong, K. Zhu, Migrating to internet-based e-commerce: factors affecting e-commerce adoption and migration at the firm level, Information Management 43 (2) (2006) 204–221.
[28] J. Hulland, Use of partial least squares (PLS) in strategic management research: a review of four recent studies, Strategic Management Journal 20 (2) (1999) 195–204.
[29] C. Iacovou, I. Benbasat, A. Dexter, Electronic data interchange and small organizations: adoption and impact of technology, MIS Quarterly 19 (4) (1995) 465–485.
[30] R.B. Johnston, H.C. Mak, An emerging vision of internet-enabled supply chain electronic commerce, International Journal of Electronic Commerce 4 (4) (2000) 43–59.
[31] R.S. Kaplan, D.P. Norton, The balanced scorecard-measures that drive performance, Harvard Business Review 70 (1) (1992) 71–79.
[32] R.S. Kaplan, D.P. Norton, Using the balanced scorecard as a strategic management system, Harvard Business Review 74 (1) (1996) 75–85.
[33] R.S. Kaplan, D.P. Norton, Linking the balanced scorecard to strategy, California Management Review 39 (1) (1996) 53–79.
[34] R.S. Kaplan, D.P. Norton, Transforming the balanced scorecard from performance measurement to strategic management: part I, Accounting Horizons 15 (1) (2001) 87–104.
[35] R.S. Kaplan, D.P. Norton, Measuring the strategic readiness of intangible assets, Harvard Business Review 82 (2) (2004) 52–63.
[36] R.S. Kaplan, D.P. Norton, The strategy map: guide to aligning intangible assets, Strategy and Leadership 32 (5) (2004) 10–17.
[37] J. Kim, E. Suh, H. Hwang, A model for evaluating the effectiveness of CRM using the balanced scorecard, Journal of Interactive Marketing 17 (2) (2003) 5–19.
[38] D. Kim, S.T. Cavusgil, R.J. Calantone, Information system innovations and supply chain management: channel relationships and firm performance, Journal of the Academy of Marketing Science 34 (1) (2006) 40–54.
[39] T.H. Kwon, R.W. Zmud, Unifying the fragmented models of information systems implementation, in: R.J. Boland Jr., R.A. Hirschheim (Eds.), Critical Issues in Information Systems Research, John Wiley and Sons Ltd., Chichester, UK, 1987, pp. 227–251.
[40] D.M. Lambert, M.C. Cooper, J.D. Pagh, Supply chain management: implementation issues and research opportunities, International Journal of Logistics Management 9 (2) (1998) 1–20.
[41] R.A. Lancioni, M.F. Smith, T.A. Oliva, The role of the Internet in supply chain management, Industrial Marketing Management 29 (1) (2000) 45–56.
[42] L. Lapide, What about measuring supply chain performance? In achieving supply chain excellence through technology, AMR Research 2 (2000) 287–297.
[43] H.L. Lee, C. Billington, Managing supply chain inventory: pitfalls and opportunities, Sloan Management Review 33 (3) (1992) 65–73.
[44] K. Lewin, Group Decision and Social Change, Henry Holt, New York, 1952.
[45] S. Li, B. Ragu-Nathan, T.S. Ragu-Nathan, S. Subba Rao, The impact of supply chain management practices on competitive advantage and organizational performance, Omega 34 (2) (2006) 107–124.
[46] T. Libby, S.E. Salterio, A. Webb, The balanced scorecard: the effects of assurance and process accountability on managerial judgment, The Accounting Review 79 (4) (2004) 1075–1094.
[47] A.S. Maiga, F.A. Jacobs, Balanced scorecard, activity-based costing and company performance: an empirical analysis, Journal of Managerial Issues 15 (3) (2003) 283–304.
[48] H. Mendelson, R.R. Pillai, Clock-speed and informational response: evidence from the information technology industry, Information Systems Research 9 (4) (1998) 415–433.
[49] C. Morgan, Structure, speed and salience: performance measurement in the supply chain, Business Process Management Journal 10 (5) (2004) 522–536.
[50] T. Moyaux, P. McBurney, M. Wooldridge, A supply chain as a network of auctions, Decision Support Systems 50 (1) (2010) 176–190.
[51] R. Narasimhan, S.W. Kim, Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms, Journal of Operations Management 20 (3) (2002) 303–323.
[52] J.C. Nunnally, Psychometric Theory, McGraw-Hill, New York, 1978.
[53] J.H. Park, J.K. Lee, J.S. Yoo, A framework for designing the balanced supply chain scorecard, European Journal of Information Systems 14 (4) (2005) 335–346.
[54] K.A. Patterson, C.M. Grimm, T.M. Corsi, Adopting new technologies for supply chain management, Transportation Research Part E 39 (2) (2003) 95–121.
[55] K.A. Patterson, C.M. Grimm, T.M. Corsi, Diffusion of supply chain technologies, Transportation Journal 43 (3) (2004) 5–23.
[56] P.M. Podsakoff, S.B. MacKenzie, J.-Y. Lee, N.P. Podsakoff, Common method biases in behavioral research: a critical review of the literature and recommended remedies, Journal of Applied Psychology 88 (5) (2003) 879–903.
[57] G.P. Premkumar, Interorganization systems and supply chain management: an information processing perspective, Information Systems Management 17 (3) (2000) 56–69.
[58] G. Premkumar, K. Ramamurthy, The role of interorganizational and organizational factors on the decision mode for adoption of interorganizational systems, Decision Sciences 26 (3) (1995) 303–336.
[59] G. Premkumar, K. Ramamurthy, S. Nilakanta, Implementation of electronic data interchange: an innovation diffusion perspective, Journal of Management Information Systems 11 (2) (1994) 157–186.
[60] G. Premkumar, K. Ramamurthy, M.R. Crum, Determinants of EDI adoption in the transportation industry, European Journal of Information Systems 6 (2) (1997) 107–121.
[61] M.B. Prescott, S.A. Conger, Information technology innovations: a classification by IT locus of impact and research approach, Data Base Advances 26 (2/3) (1995) 20–41.
[62] A. Rai, R. Patnayakuni, N. Patnayakuni, Firm performance impacts of digitally enabled supply chain integration capabilities, MIS Quarterly 30 (2) (2006) 225–246.
[63] K. Ramamurthy, G. Premkumar, Determinants and outcomes of electronic data interchange diffusion, IEEE Transactions on Engineering Management 42 (4) (1995) 332–351.
[64] K. Ramamurthy, G. Premkumar, M.R. Crum, Organizational and interorganizational determinants of EDI diffusion and organizational performance: a causal model, Journal of Organizational Computing and Electronic Commerce 9 (4) (1999) 253–285.
[65] C. Ranganathan, J.S. Dhaliwal, T.S.H. Teo, Assimilation and diffusion of web technologies in supply-chain management: an examination of key drivers and performance impacts, International Journal of Electronic Commerce 9 (1) (2004) 127–161.
[66] E.M. Rogers, Diffusion of Innovations, fourth ed. The Free Press, New York, 1995.
[67] E.M. Rogers, Diffusion of Innovation, fifth ed. The Free Press, New York, 2003.

[68] J. Ruiz-Mercader, A.L. Merono-Cerdan, R. Sabater-Sanchez, Information technology and learning: their relationship and impact on organizational performance in small businesses, International Journal of Information Management 26 (1) (2006) 16–29.
[69] A.M. Sanchez, M.P. Perez, Supply chain flexibility and firm performance: a conceptual model and empirical study in the automotive industry, International Journal of Operations and Production Management 25 (7) (2005) 681–700.
[70] H. Shin, D.A. Collier, D.D. Wilson, Supply management orientation and supplier/buyer performance, Journal of Operations Management 18 (3) (2000) 317–333.
[71] T.P. Stank, S.B. Keller, P.J. Daugherty, Supply chain collaboration and logistical service performance, Journal of Business Logistics 22 (1) (2001) 29–48.
[72] M. Subramani, How do suppliers benefit from information technology use in supply chain relationships? MIS Quarterly 28 (1) (2004) 45–73.
[73] E.B. Swanson, N.C. Ramiller, The organizing vision in information systems innovation, Organization Science 8 (5) (1997) 458–474.
[74] E.B. Swanson, N.C. Ramiller, Innovating mindfully with information technology, MIS Quarterly 28 (4) (2004) 553–583.
[75] K.C. Tan, V.R. Kannan, R.B. Handfield, Supply chain management: supplier performance and firm performance, International Journal of Purchasing and Materials Management 34 (3) (1998) 2–9.
[76] S. Taylor, P.A. Todd, Understanding information technology usage: a test of competing models, Information Systems Research 6 (2) (1995) 144–176.
[77] M.E. Thatcher, J.R. Oliver, The impact of technology investments on a firm's production efficiency, product quality, and productivity, Journal of Management Information Systems 18 (2) (2001) 17–45.
[78] P. Trkman, K. McCormack, M.P.V. de Oliveira, M.B. Ladeira, The impact of business analytics on supply chain performance, Decision Support Systems 49 (3) (2010) 318–327.
[79] V. Venkatesh, F.D. Davis, A model of the antecedents of perceived ease of use: development and test, Decision Sciences 27 (3) (1996) 451–481.
[80] V. Venkatesh, F.D. Davis, A theoretical extension of the technology acceptance model: four longitudinal field studies, Management Science 46 (2) (2000) 186–204.
[81] S. Vickery, R. Calantone, C. Droge, Supply chain flexibility: an empirical study, Journal of Supply Chain Management 35 (3) (1999) 16–24.
[82] I.-L. Wu, C.-H. Chuang, Examining the diffusion of electronic supply chain management with external antecedents and firm performance: a multi-stage analysis, Decision Support Systems 50 (2010) 103–115.
[83] S. Yeniyurt, A literature review and integrative performance measurement framework for multinational companies, Marketing Intelligence and Planning 21 (3) (2003) 134–142.
[84] A.K. Yeung, D.O. Ulrich, S.W. Nason, M.A. Glinow, Organizational Learning Capability, Oxford University Press, New York, 1999.
[85] K. Zhu, K.L. Kraemer, S. Xu, The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business, Management Science 52 (10) (2006) 1557–1576.
[86] R.W. Zmud, L.E. Apple, Measuring technology incorporation/infusion, Journal of Product Innovation Management 9 (2) (1992) 148–155.

Ing-Long Wu is a professor in the Department of Information Management at National Chung Cheng University. He received a Bachelor in Industrial Management from National Cheng-Kung University, a M.S. in Computer Science from Montclair State University, and a Ph.D. in Management from Rutgers, the State University of New Jersey. He has published a number of papers in Journal of the American Society for Information Science and Technology, Information & Management, Decision Support Systems, International Journal of Human Computer Studies, Information and Software technology, Electronic Commerce Research and Applications, Psychometrika, and Journal of Educational and Behavioral Statistics. His current research interests are in the areas of CRM, SCM, knowledge management, IT performance assessment, and behaviors in IT usage.

Chin-Hui Chang currently works for Chang Gung Memorial Hospital as a specialist in IT service division. He gained a Bachelor in Information Management from Chang Gung University and a MBA in Information Management from National Chung Cheng University. His current research interests are in the areas of IT-enabled customer service.