Serv Bus
DOI 10.1007/s11628-012-0175-5

CASE STUDY

Using the balanced scorecard on supply chain integration performance—a case study of service businesses

Hsin Hsin Chang · Chung-Jye Hung · Kit Hong Wong · Chin-Ho Lee

Received: 15 June 2012 / Accepted: 6 November 2012

Abstract Supply chains are indispensable to corporations that seek to serve suppliers and customers better, to boost organization performance, to strengthen competitiveness, and to achieve continuous success. Currently, corporations place great emphasis on both supply chains and on balanced scorecards (BSCs) to develop effective measures to evaluate firm performance. This study discusses the integration of supply chain and performance based on the BSC measures developed by Kaplan and Norton (Harv Bus Rev 71(5):134–147, 1993; Harv Bus Rev 74(1):75–85, 1996) and Brewer and Speh (J Bus Logist 21(1): 79–93, 2000). The research applies case studies and a conceptual framework, modifying propositions accordingly. The main objectives of this study are to discuss the construction and implementation of supply chains, to determine how to handle supply chain barriers and to evaluate supply chain integration performance using the idea of a BSC. Companies at different levels in the supply chain are better served by assigning different levels of importance to different types of integration. Case studies show that supply chain integration involves supplier, internal, and customer barriers. The results of these studies have suggested that integrated supply chains can be dominated by one controlling member, which can be located either upstream or downstream in the chain. A new finding in this study is that varying degrees of supply chain integration are obtained due to corporations' different positions in an industry. The study provides some insights for firms in the process of implementing a supply chain management system.

H. H. Chang (✉) · K. H. Wong · C.-H. Lee
Department of Business Administration, National Cheng Kung University, Taiwan, R.O.C.
e-mail: easyhhc@mail.ncku.edu.tw

C.-J. Hung
Department of Surgery, Medical College and Hospital, National Cheng Kung University, Taiwan, R.O.C.

Published online: 20 November 2012

Keywords Balanced scorecard · Supply chain integration · Performance evaluation

1 Introduction

Firms implement supply chain management (SCM) not only to increase firm performance and competitive advantage, but also to better serve upstream and downstream members throughout the chain and to simultaneously increase service levels (Farahani and Elahipanah 2008). From a service perspective, SCM can be defined as the management of information, processes, capacity, service performance, and funds from the earliest supplier to the ultimate customer (Ellram et al. 2004; Chang et al. 2010). In addition to improving upstream productivity, there are core activities in SCM, such as the flow of information and finance, development of relationships, and the sharing of capacity and other service processes. SCM can be also regarded as a service process within the chain moving upstream to downstream or vise-versa. However, external factors that include suppliers, customers, and a firm's internal factors may cause a failure to implement SCM (Chang 2006). Therefore, firms must understand the barriers that their suppliers and customers may face. In terms of evaluating supply chain performance, Chang (2006) pointed out that the development of supply chain schemes capable of balancing supply and demand can confer significant cost reduction, customer service, and hence, competitive advantages, by decreasing data transmission time, shortening product introduction time, and reducing supply lead time. Supply chain integration encompasses the internal integration of business functions as well as the external integration of upstream and downstream supply chain partners (Chang and Wong 2010; Holweg et al. 2005). It is assumed that supply chain integration improves performance. It is assumed that supply chain integration improves performance although quantitative measurements are often either lacking or under developed.

Some previous studies have identified some methods for evaluating supply chain integration performance. For example, Chang (2009) indicated that organizations can use the data from indexes to assess the leadership contributions, to identify potential entry barriers within markets, to predict return on investment, and to pinpoint areas where suppliers and customers are not satisfied. Hoffecker and Goldenberg (1994) proposed that contemporary performance evaluations should include multiple financial and non-financial indicators with dynamic linkage to company strategies. Brewer and Speh (2000) suggested that a generally-accepted method of supply chain performance evaluation does not exist and that a balanced scorecard (BSC) could provide a basis for one. The scorecard carries out a business' strategy, realizes its vision and links up performance evaluation and compensation systems. However, Kaplan and Norton (1992) noted that a well-balanced scorecard is not only a conventional measure of financial conditions and the rate of return on investment but also is a comprehensive measurement system including both financial and non-financial measures as well as leading and lagging indicators. In 1993 and 1996, Kaplan and Norton refined the BSC technique, which has been widely applied subsequently in academic studies and in the field of business.

Brewer and Speh (2000) proposed linkages between SCM and BSCs. The SCM framework considers supply chain goals, end customer benefits, financial benefits, and supply chain improvement. It is similar to the four managing perspectives (the financial perspective, customer perspective, business process perspective, and the innovation and learning perspective) of Kaplan and Norton's BSC concept. This concept has been adopted by many businesses, and it has been predicted that many more will adopt it in the future (Fernandes et al. 2006). These businesses present one possible approach to implement a BSC in an enterprise environment to identify a number of critical management challenges in BSC implementation activities, including key performance indicators (KPI) analysis, project management, and developing support systems. A number of findings from the research are helpful to other enterprises and strategy makers for successfully institutionalizing BSCs within their organizations.

From the service perspective, this study attempts to investigate supply chain integration and performance by three case studies from the upper level of the supply chain; adopting the concept of BSC metrics that was proposed by Kaplan and Norton (1993 and 1996), and Brewer and Speh (2000) to evaluate supply chain performance. First of all, the study described the barriers that are encountered by the three case firms when implementing a supply chain to serve the chain members and how they overcome it. Second, integration issues were studied after implementing the supply chain to understand the firm performance after the supply chain integration. Third, supply chain performance was explored from the four perspectives of a BSC (e.g., business processes, customer, financial, and innovation and learning perspectives) with some key performance indicators. And lastly, different levels or positions in the supply chain were investigated to understand the potential influence of firm position when integrating the supply chain.

2 Theoretical background and research proposition development

2.1 Implementation of supply chain

Before the study goes further to the application of a balanced scorecard (BSC) for supply chain performance measurement, barriers to supply chains and integration of supply chains need to be comprehensively understood.

Due to factors such as rapid product development, just-in-time production methods, and the ability of information technology to promote information exchange and cooperation between organizations, contemporary competition is often considered to occur between supply chains rather than between individual companies (Christopher 1998; Speckman et al. 2002; Ward and Zhou 2006). Among all of the computer manufacturers, IBM, Dell, and HP provide examples of the benefits of supply chain management, providing a level of vertical integration previously only contemplated by organizations with sole ownership of their supply chains. Despite these successful examples, supply chain integration remains a challenging task.

Chopra and Meindl (2001) and Hult et al. (2004) proposed that a relative overestimate of supply partner ability is a common cause of supply chain integration

failure. Meanwhile, Frohlich (2002) and Chang (2006) also proposed three factors that cause the failure of supply chain implementation: (1) Barriers to supplier communication often are rooted in differing perceptions, differing demand costs (Choy et al. 2003; Krause et al. 1998), and time pressures to which suppliers are subjected (Buxmann et al. 2004; Bhatnagar and Sohal 2005; Christopher 1998). (2) Barriers due to internal cultural processes, such as inertia in favor of the status quo (Cox 2001; Kotter 1995; Minner 2003). (3) Barriers from customers, such as doubts related to the financial returns on supply chain implementation, data reliability, or misinformation (Akmanligil and Palvia 2004, Corbett et al. 1999; Horvath 2001; Jayaram et al. 2000; Minner 2003).

The emergence of the global market has increased the need for flexibility and efficiency and has consequently stimulated the introduction of enterprise resource planning (ERP) and supply chain management (SCM) systems, with corporations attempting to form overall value chain systems (Chang 2006; Chang and Wong 2010 Cousins and Spekman 2003; Horvath 2001) through ad-hoc collaboration and the formation of strategic alliances (Horvath 2001; Liker and Choi 2004; Maloni and Benton 1997; Prahalad and Hamel 1990).

Babich et al. (2007) mentioned that suppliers, who compete for business with retailers by setting wholesale prices, are leaders in a stackelberg game with retailers. These retailers, facing uncertain future demand, choose order quantities while weighing the benefits of procuring from the cheapest supplier against the advantages of order diversification, and the suppliers and the channel prefer defaults that are negatively correlated. Mansini and Van Wassenhove (2009) found that the consequences of a misfit between needs and competence-building mechanisms are more severe for companies that operate in complex and dynamic environments and have informal organizational structures than for firms with rigid structures that operate in simple and stable environments. A complete supply chain includes product design, the acquisition of raw materials, production and manufacturing, and distribution and delivery of finished goods to customers, and its management has required the development of simulations and control and analysis procedures that cover production planning, inventory, and distribution (Beamon 1998; Chang 2009; Chopra and Meindl 2001; Ramda et al. 2003).

Various perspective-dependent definitions of SCM are offered in the literature on this topic. Simon et al. (2000), and Lambert and Cooper (2000) discuss SCM from the perspective of logistics and market selection, while Tan et al. (2002) consider purchasing, suppliers, and delivery logistics. Based on previous studies (Chopra and Meindl 2001; Cousins and Spekman 2003; Hult et al. 2004; Minner 2003), this study suggests that SCM is a strategy in which companies have a commitment to cooperate closely for the purpose of serving the chain partners to manage the supply chain's information flow, logistics, and cash flow for the mutual advantage of its members and the end consumer.

2.2 Integration of the supply chain

Cousins and Spekman (2003) divided inter-relationships between corporations into two categories: opportunistic and collaborative. Opportunistic relationships are

targeted at short-term price reductions and immediate returns. Company profit will probably increase because of lower short-term costs, but this will not necessarily confer a long-term competitive advantage. Collaborative relationships imply an attempt to increase long-term profits for all parties in long-term partnerships. There is some disagreement on whether integration of a supply chain is necessarily driven by downstream demands. Lambert and Cooper (2000) considered integration to be customer-driven, while Cousins and Spekman (2003) argued that it can be initiated by either customers or suppliers. Complete end-to-end supply chain integration of course involves both suppliers and customers and should lead to high customer satisfaction (Chang 2006; Hult et al. 2004). Furthermore, Swinney and Netessine (2009) found that dynamic long-term contracts allow buyers to coordinate the supply chain in the presence of default risk, and they demonstrated that supplier default offers a new reason to prefer long-term contracts over short-term contracts.

Lee and Billington (1992) mentioned that supply chain integration brings significant benefits to corporations. Prices and delivery are better than those of competing, less well- integrated supply chains. Chang (2006) categorized supply chain operations that must be integrated, including planning, execution, and transactions. Nitin Seth and Deshmukh (2006) pointed out that the importance of achieving supply chain integration is not only across internal operations but also lies with customers, material and service suppliers. Their research implied that the capabilities of supply chain integration result from both internal and external elements.

Global Supply Chain Finance goes further, proposing that the successful supply chain integration requires the integration of eight main subsystems: management of customer relationships, customer service, demand, order execution, manufacturing processes, purchasing, and product development and commercialization. Chang (2009) also suggested that the full implementation of these individual subsystems is a prerequisite for supply chain integration. When the supply chain is integrated, it can provide complete service to suppliers/distributors and firms completely, providing a win–win situation that helps to fulfill the basic objectives of supply chains (Chang et al. 2010; Nitin Seth and Deshmukh 2006).

2.3 Supply chain performance evaluation and balance scored card

Performance evaluation and management help manage resources to achieve company objectives (Jayaram et al. 2000). A good performance management system helps enterprises to create value by concentrating effort where and when it will be the most effective (Chang 2005). An effective performance evaluation should be operationally relevant, clearly defined and understood, should include all of the inputs and outputs, and it should also be economically measurable and encourage effective corrective actions.

Previous researchers have distinguished between qualitative and quantitative (Beamon 1998), cost and non-cost, strategic/operational/tactical focus, and supply chain process measures to evaluate supply chain performance (Gunasekaran et al. 2004; Shepherd and Günter 2006). Persson and Olhager (2002) considered that a combination of quality, lead time, and cost indicators provides an overall summary

of supply chain effectiveness. Bhatnagar and Sohal (2005) supported the assertion that there is a significant relationship between qualitative plant location factors (such as labor, infrastructure, business environment, political stability, proximity to markets, proximity to suppliers, key competitor locations, supply chain uncertainty, and broad manufacturing practices) and the operational competitiveness of supply chains as measured by quality, flexibility, inventory turnover, and responsiveness. Chang (2005) discussed supply chain integration at the strategic, tactical, and operational levels from financial and non-financial perspectives and evaluated supply chain integration performance from such aspects as customer service, cost management, productivity, and asset evaluation.

However, many measurement methods have lacked strategy alignment, a balanced approach and systemic thinking; they have also had difficulty with systematically identifying the most appropriate metrics (Cai et al. 2009). Bhagwat and Sharma (2007) suggested that it is more appropriate to use a balanced approach to measure and evaluate supply chain performance because the overall scenario and metrics are considered in a balanced approach, including such things as strategic, tactical, and operational levels, which include both financial and non-financial measures.

The balanced scorecard (BSC) was first proposed by Kaplan and Norton (1992). BSCs attempt a comprehensive measurement system integrating strategic measurement and management systems throughout organizations, applying both financial and non-financial metrics to external and internal aspects of company operations. The BSC is capable of combining objectives, quantitative data, and subjective judgments, and includes the long-term trend monitoring and forecasting facilities required to support strategic planning. Kaplan and Norton (1996) applied a cause-and-effect rationale to the achievement of objectives, employing feedback from appropriate monitoring as the basis for a continuous process of organizational learning.

Brewer and Speh (2000) developed a cause-and-effect SCM framework with SCM goal content, end customer benefits, financial benefits, and SCM improvement. This content was proposed to have an inter-relationship with the four core dimensions of the BSC approach, which includes business processes, customers, finances, and an innovation and learning perspective (Brewer and Speh 2000). Bhagwat and Sharma (2007) made a more specific study on developing the measurement and evaluation of supply chain performance by the BSC concept. The SCM indicators of each BSC dimension are summarized and illustrated in Fig. 1, and they demonstrate high similarity between the indicators of Brewer and Speh.

It has been suggested that a key driving principle of BSC is the idea that indicators should be aligned with strategic objectives and business excellence (Bullinger et al. 2002). Gunasekaran et al. (2001) pointed out that the supply chain performance measurement should be strategic, tactical, and operational (Park et al. 2005). Thus, supply chain performance can be measured completely by adopting the BSC approach because each corporate mission and the strategic goals related to it will require a unique set of measures (Bhagwat and Sharma 2007). The advantages of using the BSC approach to measure SCM include (1) the BSC model integrates different perspectives on company operations and accommodates the relationship of an organization with its external trading environment. (2) The application of the BSC performance evaluation method requires that the monitoring methods of all

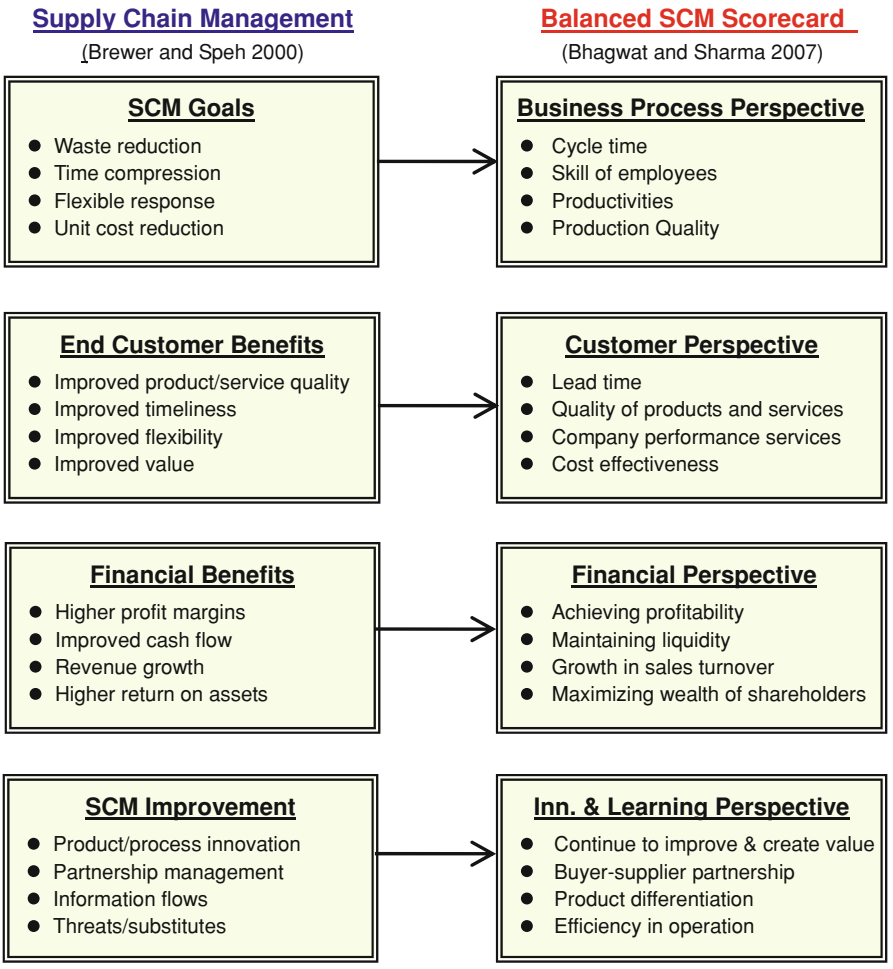

Fig. 1 The interrelationship between SCM and the BSC. (*Source* Bhagwat and Sharma 2007; Brewer and Speh 2000; Kaplan and Norton 1993 and 1996)

organizational partners are consistent. (3) The objectives and measures for different supply chains could be designed separately based on different localized demands. Similarly, (4) the BSC method helps insure that staffs remain aware of the operational objectives of performance measurements, which should neither be an end in themselves, nor tools for rewards or punishments.

2.4 Research propositions

Maloni and Benton (1997) and Krause et al. (1998) indicated that they believe that perception and demand cost variations among suppliers have great impact on the integration of supply chains, and they suggested that corporations should not depend on one particular supplier and ignore other partners. Narasimhan and Jayaram

(1998), Frohlich and Westbrook (2001), and Ahmad and Schroeder (2001) claimed that high levels of supply chain integration in upstream and downstream corporations bring greater benefits but require mutual confidence and trust between the partners, flexibility and commitment to the integration process. Moreover, Kotter (1995) and Christopher (1998) suggested that the time pressure caused by the reduction of lead time is a major barrier to integration, generating heavy resistance in favor of the status quo. This in turn can generate external resistance from influential and informed corporate customers due to doubts about increasing costs in regard to supply chain integration and the reliability of data (Chang 2005; Corbett et al. 1999). Hence, the following research proposition is proposed:

P1 Implementation of supply chain barriers has negative effects on the integration of supply chains.

Horvath (2001) and Chang (2006) suggested that supply chain integration can bring such benefits as total cost reduction, inventory reduction, and increased information sharing, with consequent improvements in profitability, service levels, technology innovation, and product design and in the financial and operational performance of supply chain partners. Tan et al. (2002) and Ramda et al. (2003) proposed that customer-oriented visions and effective supply chain integration confer competitive advantages and improve business performance. The Council of Logistics Management claimed that the supply chain integration was the key to the global logistics performance of enterprises in 2000. With the help of supply chain integration, corporations can improve their responsiveness toward customers' demands and show significant improvement in business performance. This relationship is stated as:

P2 Integration of a supply chain has positive effects on evaluations of firm performance.

This study is aimed at evaluating the performance of supply chain integration from the perspective of a BSC. The literature has identified some significant barriers to supply chain integration with consequent impacts on firm performance. These barriers involve suppliers, customers, and internal business processes. Furthermore, supply chain integration is intended to integrate customers, suppliers, internal processes, IT planning, measurement, and relationships. Supply chain performance evaluation covers financial, customer, and business processes, as well as innovation and learning perspectives. The initial research model is illustrated in Fig. 2.

3 Methods and case studies

Eisenhaeds (1989), Alavi and Carlson (1992), and Yin (2003) described a case study as an exploratory technique with a focus on observation. Researchers collect actual business operation data in the field; however it is likely that independent and dependent variables and precise measurement methods are not identified a priori. Case studies may follow definite procedures, although these procedures are not uniformly applied. Eisenhaeds (1989) proposed several processes: defining questions, selecting cases, utilizing instruments and data, getting involved with the

Fig. 2 Conceptual framework of this study

scene, analyzing data, establishing hypotheses, comparing literature, and drawing conclusions. Case studies are suitable for researching new questions which have not been extensively studied and which lack a theoretical framework or a priori hypotheses to be tested. Case studies are regarded as particularly appropriate for detailed description and investigation of a specific situation (such as a business failure) and for preliminary investigation in academic research. Generalization can come later.

Current studies on BSCs emphasize supplier selection. Published studies of the influences on supply chain integration are relatively few, generally limited to a financial perspective and are typically undertaken by academic rather than industrial practitioner personnel. The majority of industrial studies that do exist are limited to a description of the initial adoption of the method. We therefore applied case studies and questionnaire survey methods to a comparative description of academic and industrial perceptions, derived from interviews, modified the research framework according to the interview feedback, and then developed a questionnaire to identify key variables.

The three international enterprises in the case studies have already adopted an SCM system. The interviewees were the SCM project owners, including Vice Manager, Mr. Kao, and the IT Department Manager, Mr. Chang, from the F Corp., the IT Director, Mr. Ke, and several SCM system maintenance engineers from the W Technology Corp., and the Vice Director of Finance, Mr. Chang, and several SCM project engineers from the S Steel Corp. The main interview topics included the encountered barriers to supply chain integration, the approaches employed to overcome these barriers, the integration of the supply chain, and the linkage between supply chain performance, and the BSC. Table 1 summarizes the case organizations' background information, supply chain systems, and response time.

3.1 Case 1: F Mechanical Corporation

Company F was established in 1974, and is the only publicly quoted manufacturer of plastic injection molding machines, with 400 employees and plants in Taiwan. The company has a comprehensive product line, including hydraulic, hybrid, and all-electric injection molding machines. The innovative hybrid machines are market leaders in the local industry. Supply chain integration helps the company respond effectively to the high demand variation, small order volumes, high product diversity, and short delivery time which characterize the market sector, by effectively providing end-users with direct access to the complete value chain. In 2002, Company F was approved for an e-Business project sponsored by the Industrial Development Bureau (IDB) of the Ministry of Economic Affairs (MOEA), becoming

Table 1 Summary of case organisations: SCM background and systems

Case	F Mechanical	W Technology	S Steel
Industry sector	Machinery manufacturer	Electronics manufacturer	Steel manufacturer
Implementation of SCM system	Four years	Three years	Six years
Use of software	Metal Industries R&D Center from Taiwan Industrial Development Bureau (IDB)	SAP	Self-developed (over 30 years)
SCM system: planning	Planning for delivery, manufacturing, production scheduling, suppliers; SCM network planning and design	Planning for manufacturing, production scheduling, suppliers, forecasting; SCM network planning and design	Planning for delivery, manufacturing, production scheduling; SCM network planning and design
SCM system: execution	Order, inventory, supplier collaboration, transportation management, and SCM	Order management, inventory, warehouse, global logistics management, and SCM	Inventory, global logistics, warehouse, and transportation management
Response time	Immediate	Immediate	Immediate

the only specifically e-business enterprise in the plastic injection molding machinery industry. The internet-mediated ordering system allowed rapid response to demand variation, lower error rates and processing time, and improved workflow, forming the basis for an e-SCM system linking 100 factories as part of an overall e-business strategy.

3.1.1 Barriers in the course of implementing a supply chain system

Ninety-eight percent of Taiwanese plastic machinery manufacturers are small-to-medium scale enterprises, so there are a large number of potential competitors and suppliers, increasing the importance of maintaining long-term partnerships. Company F introduced enterprise resource planning (ERP) in 1997 and e-SCM strategies in 2001, being assisted by the Metal Industries R&D Center of the IDB of the MOEA. As illustrated in Table 2, some problems were encountered in the construction phase of the e-SCM. Yet, as soon as the system was fully implemented, it became relatively trouble-free.

3.1.2 Integration after implementing SCM system

Company F is centrally located in the plastics molding machinery supply chain. While they emphasize upward integration through purchase planning, supplier management, and quality planning for upstream suppliers, they also manage production flow for downstream customers based on their demands for quality, delivery dates, and so forth.

Table 2 Company F: a summary of barriers encountered during supply chain implementation and measurement indices for the BSC

Barrier	Item	Description
Supplier	Low willingness to cooperate	In conventional industries, companies are often deterred by the complexity of the supply chain system and are therefore unwilling to cooperate
	Insufficient IT capabilities	Conventional industries using traditional voice and written inter-company communication may resist using the SCM system
	Cost	Company implementation was partly funded by Taiwan's MOEA subsidies
Internal	Insufficient IT capabilities	When traditional written media are transformed to computerized ones, resistance due to insufficient information capabilities may be encountered, especially in the purchase department
	Big change of special order	20 % of the company's production is customized, requiring special collaboration between sales, production management, and R&D. If the system does not accommodate itself to these parts, resistance will be encountered
	Cost	Partly funded by MOEA subsidies, which help overcome the initial investment hurdle
Customer	Low levels of e-Business	Conventional industries familiar only with traditional voice and written inter-company communication may resist use of a web-based information system
	Loyalty/trust	Even long standing customers (>3 years) may not become integrated into SCM
	Cost	Early adopters may require the additional encouragement of MOEA subsidies to overcome the initial investment hurdle

Performance	KPI indicators
Financial	20–25 % increases on business volume, 2–3 dollars for EPS, machinery sales accounting for 50 % of business volume, 50 % increases on cash flow
Customer	Customer satisfaction achieves 80 %, customer repurchase rate achieves 80 %, the number of customer complaints decreases, on-time delivery rate increases
Internal process	Decreasing unusual incident rate for purchasing, production, and development; improving the efficiency of purchasing, production, and development; developing 10–12 agencies, TQM, and process automation
Innovation and learning	Training, developing machinery, improving information capability, improving product innovation, SCM improvement procedures, emphasizing encouragement for employees, establishing long-term partnerships, emphasizing employee satisfaction

(1) Customer integration: Customers can be divided into agents and end-users. The precise arrangements for agents vary with their technical maturity, financial status, and individual demands. In order to build a long-term relationship with end-users, different methods of customer retention may be used based on regional and individual requirements. Company F applies flexible manufacturing procedures for quick response to increase customer satisfaction.

(2) Internal integration: Company F employs e-business techniques for internal as well as external integration. As a result, business process re-engineering (BPR) was a prerequisite to SCM implementation. BPR here includes making information flow electronic, training staff from all levels with necessary techniques, standardizing and simplifying workflow, and making commitments to staff to build a relationship based on mutual advantage and trust.
(3) Supply and service integration: Company F built up strategic alliances with upstream factories. It established a management system to evaluate suppliers' performance and offered technical training for suppliers' staff via a union committee (80 % of the supply chain workforce consisted of union members). For cash flow, China Trust Bank provided umbrella finance and credit services to the supply chain as a whole.
(4) Technology and planning integration: In accordance with e-strategies for manufacturers proposed by the MOEA in Taiwan, Company F introduced computerization, migrating to an open client–server system from a closed centralized architecture. The IT department was responsible for the integration of internal information while the integration of the supply chain was accomplished via third party platforms.
(5) Measurement integration: Performance relative to strategic goals was measured by using a wide range of financial and non-financial indicators, applied internally, across business boundaries or to the supply chain as a whole. Internal training increased, and the staff was encouraged to pursue further education. For internal processes, different indices were applied for different production procedures. A prioritized cost management scheme was introduced, pursuing maximum profit, return on capital, and return on equity. Customer satisfaction and customer repurchase rates were monitored.
(6) Relationship integration: Performance benchmarks and coordination arrangements for satellite companies are agreed upon in collaboration with the trade unions from each company to the mutual benefit of all the supply partners and their individual employees.

3.1.3 Using BSCs to evaluate business performance

Kaplan and Norton (1992) proposed that a complete BSC should be a comprehensive performance evaluation system consisting of both financial and non-financial indicators conforming to organizational visions and strategies. The measurement indices for BSCs cover financial, customer and internal processes, and KPI measurement indices are used for innovation/learning perspectives. Please refer to Table 2.

3.2 Case 2: W Technology Corporation

W Technology Co. is the biggest passive component manufacturer in Taiwan, with 1600 employees at plants in Taiwan, Singapore, Malaysia, and China. Its main products are passive chip components and control sensor components. Company W

as a basic component producer, is at the start of the supply chain, so the strength of its relationship with downstream customers is of critical importance. Under the MOEA's B2B plan, Company W participated in e-strategy for the Information Industry. Upstream suppliers are connected via a Play Real Poker Online (PRPO) system, and downstream customers are connected via a System Applications Products/Advanced Planning Optimizer (SAP/APO) for SCM system.

3.2.1 Barriers in the course of implementing SCM system

Company W introduced a SAP-ERP in 1997, which worked well but was limited to checking the inventory. In order to meet customer demands related to delivery, Company W introduced SAP/APO SCM in 2003, which allowed customers to connect directly with its ERP to simultaneously confirm inventory and determine lead time when placing an order, speeding up product delivery. The barriers encountered during the initial SCM implementation are shown in Table 3.

3.2.2 Integration after implementing the SCM system

Company W is positioned toward the upstream supply chain, controlling the quality of raw materials from suppliers and providing the finished and semi-finished goods to customers, with the declared goal of becoming one of the top three passive component manufacturers in the world. Although there are long-term partnerships in both directions, Company W emphasizes downward integration as a means of meeting customer demands.

(1) Customer integration: Company W's main customers are communications and motherboard firms, including global brands such as Sony and Liter-on. In order to sustain long-term commercial partnerships, Company W applies flexible manufacturing, quick response, regional differentiation, and quality differentiation based on customer demands.
(2) Internal integration: Company W was the first enterprise in its industry sector to use SAP-APO to coordinate internet ordering, production and inventory. When a customer places an order, the system instantly schedules its manufacture and delivery. The company's high level of commitment to SCM implementation as a strategic policy insured that incompatibilities with the ERP were overcome.
(3) Supply and service integration: Upstream raw materials are mostly controlled by large suppliers with whom Company W has developed long-term partnerships and has evolved integrated management information systems in recent years.
(4) Technology and planning integration: Development of SCM was a response to customer requests. Information was communicated via XML to the hub of the Institute for the IT Industry, which provided an experimental middleware platform during development and early deployment. Later orders, production, and delivery information were linked to operational platforms of each partner enterprise. Company W confirmed the reliability of order processing via the SAP-APO link with the internal ERP.

Table 3 Company W: barriers encountered on supply chain and performance indicators

Barrier	Item	Description
Supplier	Information capability	The supplier information system development status sometimes did not provide sufficient data access, accuracy and availability, leading to non-adoption
	System compatibility	The information systems of suppliers were sometimes incompatible with the integrating companies, leading to non-adoption by some suppliers
	Cost	Constructing an SCM system is expensive, and in this case is partly funded by MOEA subsidies
Internal	IT ability of staff	Staff IT competence was found to be essential for SCM success
	System compatibility	The SCM system was based on the earlier ERP system. The compatibility between these two systems overcame a potential barrier to the implementation of SCM
	Cost	Partly funded by MOEA subsidies
Customer	Customer cooperation	Demand controls the supply chain and comes from downstream customers. If they are not integrated into the management system will meet their demands less efficiently. A lack of customer cooperation is therefore a barrier to SCM implementation
	System compatibility	The information systems of customer companies were sometimes incompatible, leading to non-adoption by some customers
	Cost	Constructing an SCM system is expensive, and some customers sought development and implementation funding from the MOEA

Performance	KPI indicators
Financial	Sales growth and profitability, profit margin of supply chain participants, return on assets, net profit, cost reduction rate/cost reduction, capital budget, return on capital utilization, cash flow/turnover rate, costs compared with competitors, profits and capital, Earnings Per Share, profit per employee
Customer	Average delivery time, customer complaints, market share, customer repurchase rate, customer contacts, customer profitability, new customer rate, customer satisfaction, key customer selling rate, key customer objectives, customer share, on-time delivery rate, customer return rate
Internal process	Automation index, time to market of new products, faulty goods return rate, project achievement rate
Innovation and learning	Staff training, employee satisfaction, information capability, employee motivation, team performance, product process innovation

(5) Measurement integration: Metrics were set based on business strategies and were applied at the departmental and individual levels. Line managers had to insure that each employee's KPI was consistent with corporate objectives.
(6) Relationship integration: Company W not only pursued maximum profit but also sought to promote cooperative and mutually beneficial long-term relationships with supply chain members by sharing information, profits, and risk.

3.3 Using BSC to evaluate business performance

The performance indicators applied at Company W are divided into four groups as shown in Table 3.

3.4 Case 3: S Steel Corporation

S Steel was founded in 1971 as a private enterprise, nationalized in 1977 following an under-capitalization crisis, and re-floated as a private company in 1995. Its main products are hot rolled and galvanized steel, especially girders and rebar for the construction industry, with value added from consultant engineering services to product users. Information systems have mostly been developed in-house based on specifically identified requirements. One of the characteristics of bulk steel is that long-term supply contracts are the industry norm, reinforced in S Steel by cooperation on facilities maintenance with upstream suppliers and with technical consultancy and logistics services to downstream customers. These arrangements evolved into an SCM spanning the industry, initially with a dedicated telephone system, then an ERP, e-commerce system applications in 1998 and a full SCM implemented in 2000. Currently, all of the upstream and downstream partner companies can complete all transactions via the Internet.

3.4.1 Barriers in the course of implementing the SCM system

S Steel's information systems, such as ERP, SCM, and e-commerce were all developed by themselves. Company S led the supply chain, encouraging upstream facility maintenance companies and downstream customers to join the SCM. When constructing the SCM system, a motivating method was applied. However, the levels of information for conventional industries were not high enough. Several barriers that Company S faced when constructing the supply chain are shown in Table 4.

S Steel, a conventional steel company, started e-business implementation early and was consequently the dominant partner in its supply chain. E-business systems were developed in-house to meet specific business needs, but resistance was encountered due to the low level of IT capability in this "traditional" heavy industry sector. When executing SCM, they faced barriers from suppliers (concerns about insufficient information capability and cost increases), the company itself (staff concerns over loss of independence), and customers (insufficient information capability). These issues were addressed by taking a gradual, evolutionary implementation approach (starting with an online bid submission procedure) and by providing partner organizations with technical assistance.

3.5 Integration after implementing SCM system

The ERP system has evolved from Company S's original accounting systems, and covers materials, machining, finance, manpower, marketing, and manufacturing. There are more than 6000 terminals, with some in every plant, and an average of

Table 4 S Steel: barriers to constructing supply chain and performance indicators

Barrier	Item	Description
Supplier	Low levels of computerization	Conventional industries frequently exhibit a lot of resistance toward information systems when introducing SCM
	Low willingness to cooperate	In conventional industries, corporations will initially have concerns about the complexity of SCM system. Therefore, they are unwilling to cooperate
	Cost	Constructing a supply chain takes a lot of funds, and it causes cooperative companies to be unwilling to join the SCM system
Internal	Staff independence	Company S adopted information systems long ago. Nevertheless, when there is e-business, there are barriers. Employees will be barriers when they are unwilling to empower
Customer	Low levels of information	Downstream industries belonged to conventional manufacturers. Normally, the communication is through records/telephone. Resistance will occur in implementing SCM system

Performance	KPI indicators
Financial	Sales growth and profitability, profit margin of supply chain partners, return on assets, profit margin, net profit, cost reduction rate, analysis on capital budget, return on capital utilization, turnover rate, cost compared with competitors, profits and capital, EPS, profit by employee, economical value added, performance bonus
Customer	Average waiting time, customer complaints, market share, customer repurchase rate, customer profitability, new customer rate, response to customers' demands, key customer selling rate, key customer objectives, customer share, on-time delivery rate, customer return rate, customer satisfaction with e-commerce
Internal process	Employee productivity, automation index, productivity, return rate, collaboration of internal departments, delivery cost
Innovation and learning	Staff training, employee satisfaction, cooperation of individuals and the organization, information capability, employee motivation, partnership management, process improvement of SCM

300 million transactions per day, making S Steel one of the largest scale information system users among conventional industries. Vice Director, Dr. Chang, of the MIS department, indicated that the SCM system had evolved from the ERP system and that it emphasized downstream integration, reflecting the company's position toward the upper end of the supply chain.

(1) Customer integration: This is a priority, with the internal ERP automatically-scheduling production (often involved with customized manufacturing) on receipt of a customer order via the Internet. Due to batch production constraints, it is only possible to predict the weekly (rather than the daily) delivery, but customers can track order progression via the Internet. In addition, S Steel is exploring the provision of e-payment arrangements with local banks.
(2) Internal integration: Information availability is high because internal information systems have been integrated since 1976. Manufacturing procedures

are relatively simple and rationalized by the means of systems running across departmental boundaries.

(3) Supply and service integration: Bulk raw materials such as iron ore and coal are supplied under long-term contracts. In addition, the company has reinforced its relationship with these suppliers using its e-business system to source upstream maintenance services for them.

(4) Technology and planning integration: Company S has developed a complete ERP system for internal communication. Externally, the link with customer SCM is provided by a commercial i2 systems integration package, which has to provide accurate delivery times, demand forecasting, and scheduling.

(5) Measurement integration: Metrics are set based on business strategies and are applied at both the departmental and individual levels. Line managers have to insure that each employee's KPI is consistent with corporate objectives.

(6) Relationship integration: Company S is positioned at the upstream end of the supply chain, emphasizes customer relationship integration and seeks to promote cooperative and mutually beneficial long-term relationships by providing additional services, such as design consultancy (to structural steel users) maintenance, logistics services (to suppliers and customers) coordinating these services via its e-business system, which contributes to the benefit of all supply chain members.

3.5.1 Using BSC to evaluate business performance

Four indicators for performance appraisal of S Steel are shown in Table 4.

4 Conclusions and discussion

4.1 Case summaries

4.1.1 Barriers in the implementation of SCM system

Company F is a relatively small enterprise, and the establishment of long-term partnerships with suppliers using ERP and e-business systems was considered essential to offset their relative lack of economies of scale. The implementation barriers caused by the main supplier were its insufficient IT capabilities and its concern over costs. Internally, the main issues were the need to develop procedures for special order processing and concern over costs, and there was an initial reluctance to cooperate among customers, due to unfamiliarity with, and dislike of, the system interface. They tried to resolve these issues through active explanation and promotion of the system via an industry steering committee.

Company W is at the start of SCM to respond to the demand from downstream customers. The principle barriers from suppliers and business internal process have been incompatible system interfaces and concern over costs. Incompatible system interfaces have also been a problem for customers and are partially responsible for

non-cooperation. As a high-tech enterprise with highly developed IT capabilities, the company was well placed to resolve technical issues, and active coordination and communication have been employed to lower conflicts.

Although S Steel is a conventional steel company, it started its e-business strategy early and consequently controlled its supply chain. When executing SCM, they faced barriers from suppliers, the internal company, and customers. These issues were addressed by taking a gradual, evolutionary implementation approach, and by providing technical assistance.

4.1.2 Integration after implementing SCM system

As these three cases are from different industries, their supply chain integrations are somewhat different.

(1) Customer integration: Company F is positioned near the downstream end of the supply chain. Customers include general agents and end-users. For end-users, product customization is applied. Company W is situated at the upstream end of the supply chain, with customers mainly in the communications equipment and motherboard sectors, and it values long-term partnerships with customers, adopting flexible manufacturing and quick responses to meet their needs. S Steel, as a supplier of basic industrial materials, is also positioned at the upstream end of the supply chain, and it provides customized manufacturing to customers, in response to orders received via the Internet.

(2) Internal process integration: Company F carried out comprehensive BPR as part of its e-business programs, with employees trained to use simplified, standardized flowcharted procedures. Company W was the first enterprise to use SAP-APO to coordinate internet ordering, production, and inventory. S Steel achieved similar cross-departmental coordination largely through internet-based information systems developed in-house.

(3) Supplier and service integration: Company F executed strategic alliances with upstream companies supplying raw materials, components, and moldings factories, with an SCM mechanism to evaluate supplier performance, providing training if necessary. The raw materials used by both Company W and Company S were all supplied under long-term contracts with global enterprises.

(4) Technology and planning integration: The framework for Company F was transformed from a closed, centralized system to an open-ended, client–server one. The integration of internal information systems was conducted in-house by the IT department, while a platform developed by IDB-MOEA managed the integration of external supplier information systems. Company W used SAP-APO for the internal ERP, with linkages to external partners via XML. Company S had a comprehensive ERP system developed in-house, with external linkages organized via a commercial package from an i2 system.

(5) Measurement integration: These three cases all put equal emphasis on their financial and non-financial performance measurements (such as the achievement of tasks, the achievement of projects, and the achievement of quality management). Rewards were directly linked with the measurement results.

(6) Relationship integration: F and S companies played a leading role in the supply chain integration. Company F cooperated in the provision of technical assistance and established a coordinating committee. S Steel initially established a dedicated telephone line for customers and encouraged them to place orders on line by price discount. Company W led the supply chain integration as a downstream partner, building interdependent cooperative relationships with supply chain members and increasing profit margins for all participants.

4.1.3 Using BSC to evaluate business performance

The present study attempts to use BSC to evaluate supply chain integration performance. Business performance is examined from four different perspectives, and all three companies had better financial performance after implementing SCM. Company F had significant growth in revenue while Companies W and S showed increased labor productivity. After executing SCM, Companies F and W could track raw material delivery lead times and reduce production cycle times, resulting in faster delivery and higher customer satisfaction. Customers of S Steel could complete all transactions online and track all operations transparently, leading to improved customer satisfaction. All three companies emphasized continuous production improvement with regular training as a means of increasing employee satisfaction and effectiveness.

4.2 Modification of research model: from case findings

The four dimensions of BSC discussed above reinforced each other and were reinforced by the company strategies that they planned to carry out. On the basis of case studies and a literature review, the research model was modified as shown in Fig. 3 by the inclusion of a proposition that the relative position of a company in the supply chain will affect supply chain integration, formulated as proposition 3: companies at different levels in the supply chain will assign different levels of importance to different types of integration. Upstream companies in the supply chain attach more importance to customer integration, and downstream companies in the supply chain attach more importance to supplier integration.

4.3 Discussion

Kotter (1995), Krause et al. (1998), Corbett et al. (1999), Christopher (1998), Frohlich (2002), and Chang (2006) suggested that there are three causes of supply chain integration failure, which include supplier, internal, and customer barriers. All of these three barriers were reported to hamper supply chain integration efforts using our three case study organizations although there were differences in emphasis. In order to get a balanced view of company performance, Kaplan and Norton (1996) proposed assessing it from the customer, business process, and innovation and learning perspectives as well as from the usual financial perspective. Brewer and

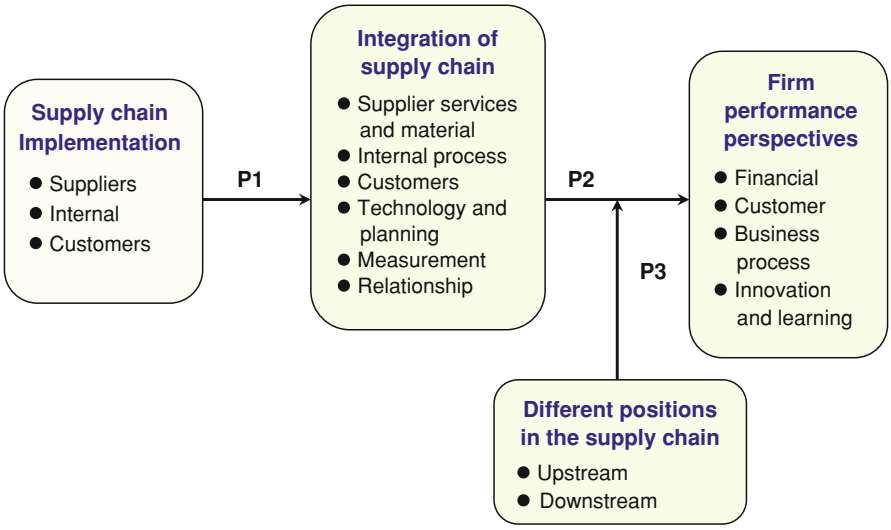

Fig. 3 Modified research model: from organizational case findings

Speh (2000) applied this BSC approach to the evaluation of SCM, arguing that it provided a conceptual framework hitherto lacking in SCM evaluation. This study applied the same approach to an evaluation of SCM in three Taiwanese companies and found it to offer a useful means of classifying performance measures which was consistently applicable to the three case study organizations.

The three case study companies had carried out BPR before implementing SCM and the internal and supplier barriers had already been reduced to some extent, leaving the principle barriers reported by our interviewees relating to customer integration. These barriers have apparently been substantially overcome in the case study organizations, which reported large improvements in many of the performance indexes they use. This is consistent with the assertion of Maloni and Benton (1997) and Chang (2009), who suggested that supply chain integration can reduce inventory costs, increase information sharing, and improve service quality, innovative technology, product design, and the financial performance of the members of every supply chain.

The case study results suggest that integrated supply chains tend to be dominated by one controlling member company, which, if influential enough, can be located at the upstream end of the chain (e.g., S Steel) even though the demand originates downstream. This controlling company not only increases its own benefits but also improves the overall business performance of chain members by providing the means of integration. From a service perspective, firms that were located in different positions played different roles in the chain with regard to serving other members. For example, S Steel was located upstream; they negotiated long-term contracts with suppliers based on customer demands. F Mechanical, on the other hand, was situated downstream; they accomplished procurement and quality control of materials. When the supply chain was integrated, both upstream and downstream members could be

served completely, which was beneficial to both parties in terms of improving firm performance throughout the chain.

4.4 Implications and limitations

The case studies provide some implications to firm managers. First, when firms implement a supply chain system, managers are able to gain some insights from supplier, internal, and customer perspectives as well as from different positions of the supply chain for the purpose of mitigating the potential barriers which may be encountered. Second, firms should pay more attention to the integration of customer demand, internal processes, suppliers and services, technology and planning, financial measurements, and member relationships, which drive and facilitate supply chain success. When the firm's supply chain system can be integrated completely based upon the service perspective, the chain members not only can provide services to each other better (from upstream to downstream or vise-versa) but also can enhance customer service levels to meet their needs better.

Third, as mentioned by Bhagwat and Sharma (2007), supply chain performance can be completely measured using BSCs. Firms are encouraged to adopt BSCs to measure supply chain performance. The case studies on this topic have elaborated on the key performance indicators for each dimension of BSCs. This is useful not only for firms and managers but also provides clear direction to researchers for accurate measurement of each performance.

This study is limited to only conducting a qualitative analysis (i.e., case study). A quantitative field study could enhance reliability and explain supply chain integration issues more completely.

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