The impact of using a cloud supply chain on organizational performance

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Abstract

Purpose – This study aims to indicate the advantages of using cloud computing services, including the ways in which firms use cloud-based services to achieve accessibility, better communication, flexibility and effective provision of services. However, little evidence has been obtained related to the effectiveness of applying cloud computing services to supply management chains.

Design/methodology/approach – In this study, a sample of 223 top 1,000 manufacturing firms in Taiwan that had implemented cloud-based supply chain management systems (CSCMs) was surveyed to determine what kind of internal resources in these companies were allocated to this implementation effort, how collaborative relationships were established in the existing supply chain to help make the transitions successful, how well their systems are working now that they have been implemented and whether these new systems have improved cycle time performance and the overall performance of their organizations. The study also examines the interrelationships among these variables.

Findings – The results reveal that, from the perspective of the managers who were surveyed, an effective allocation of internal organizational resources does have a positive, strong effect on external CSCM conditions. They also showed that when the relationship between internal and external resources is well constructed, the result is that CSCM improves supply chain management cycle time performance, which, in turn, leads to positive organizational performance.

Originality/value – The study reports some useful insights from the managers of CSCM systems related to how the execution of CSCM solutions can improve cycle time and organizational performance by enhancing internal organizational management and joint collaboration among supply chain partners. The findings from this survey will be useful to managers who are considering creating cloud-based supply management systems in the future.

Keywords Cloud computing services, Resource dependence theory, Supply chain management, Organizational performance

Paper type Research paper

1. Introduction

Enterprises have been facing more dynamic, extreme changes in their market environments than ever before (Makkonen and Johnston, 2014). The success of an individual company is not something that effects that business alone but also involves service delivery and the supply chain to which that business belongs. Supply chain management is an activity where businesses with divergent backgrounds collaborate with one another to coordinate logistics and production planning and maintain a shared flow of cross-function information (Barratt and Barratt, 2011). Businesses must attend to supply chain relationships and focus on collaboration and coordination among their supply chain partners if they are to be successful in achieving a competitive advantage by allocating resources appropriately and developing competitive practices within the supply chain (Teller *et al.*, 2012; Paulraj and Chen, 2007). To achieve a competitive advantage, it is important for business partners to integrate their logistic systems and other related activities effectively and to maintain long-term relationships that will enhance key outcomes (Hult *et al.*, 2007).

Supply chain management (SCM) discipline, coordination, management and the integration of multiple activities is a complex, dynamic process that involves various types of workflow across internal and external organizations that are directly involved in meeting customer demands (Cooper *et al.*, 1997). Cloud computing services, although still considered to be in the early stages of adoption, are becoming a popular choice for businesses. Cloud-based solutions have been used

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multidimensionally in various supply chains (Durowoju *et al.*, 2011). Some research studies have compared traditional approaches to supply chain management and have found that cloud SCM provides organizations with quicker, more effective ways to identify and apply external technical solutions designed to improve on-demand services and operational efficiency (Stieninger and Nedbal, 2014). It is difficult for a firm to compete alone successfully in an intense market environment in which customer demands change rapidly. For example, MacCarthy *et al.* (2016) point out that cloud-based computing services and open internet platforms enable businesses to maintain competitive advantage by making it possible for them to shift production from a focus on volume to a focus on customization. Resource dependence theory (RDT) suggests that firms can reduce uncertainty about the reliability of their supply lines by collaborating with other firms in a way that is mutually beneficial (Hillman *et al.*, 2009). Cloud computing services can be of great assistance in this regard.

RDT, commonly known as the leading theory in organizational and strategic management (Hillman *et al.*, 2009), has been used to determine how to form interorganizational relationships that will help organizations obtain the resources they need to reduce uncertainty (Auster, 1994; Pfeffer and Salancik, 1978). Prior RDT studies have been based on the concept of interdependence and suggest that the success of supply chain relationships depends on coordination and cooperation between supply chain partners to leverage resources and produce mutual benefits (Chen *et al.*, 2004).

Few studies focus on cloud supply chain adoption contexts such as cloud computing usage intention (Cegielski *et al.*, 2012; Gupta *et al.*, 2013), particularly from the perspective of the internal and external relationships among the various parties. Consequently, the important issue of what internal and external resources affect the execution of a cloud supply chain specifically as it relates to cycle time and organizational performance deserves investigation with specific research focuses using the resource dependency theory. With that motivation, this study is aimed toward addressing the following research question:

RQ1. What internal and external factors affect execution of a cloud supply chain system in terms of cycle time and organizational performance?

To answer this question, the primary objectives of this study are, thus, twofold. First, a transition from a technical perspective to a relational perspective suggests that the key to the success of the execution of a cloud supply chain lies not only in support from internal resources but also in the relational external collaboration situation of supply chain partners. Consequently, in this study, a theoretical model is developed to evaluate the success of a cloud supply chain execution system in terms of organizational performance by integrating both technical and relational views using the resource dependency theory (Auster, 1994; Chen *et al.*, 2004) as the theoretical basis.

In addition, to the emphasis on the important effects of execution cloud SCM services on cycle time and organizational performance, in this study, a set of mediating effects is proposed because such effects may comprise the most important antecedents of impacts of SCM execution on organizational performance (e.g. supporting resources, joint goals and relationship factors) based on resource dependency theory. This makes the resource dependency theory appropriate for the purposes of this study because it is a view from an interdependence perspective.

2. Resource dependence theory and cloud supply chain management

The RDT suggests that organizations must rely on external firms to obtain the key resources necessary for their survival (Pfeffer and Salancik, 1978). The concept of the RDT is based the idea that a company's demand for rare outside resources can best be answered through cooperation with other outside organizations (Handfield, 1993). The theory claims that organizations face a highly uncertain environment and that they need to build useful relationships (Pfeffer and Salancik, 2003; Barringer and Harrison, 2000). In addition, the RDT describes how to connect internal organizational resources with other organizational relationships. These include ways in which organizations can develop policies related to the formation of alliances, agreements on research and development, joint marketing contracts and buyer-supplier cooperation agreements (Barringer and Harrison, 2000). For example, when a firm has vital resources or access to a specific customer base, other firms in the supply chain may depend on the focus firm (Hofer *et al.*, 2012). This implies that a social network is a valuable information pipeline that provides both opportunities and constraints on firm actions and precipitates important behavior and performance based on alliances (Gulati, 1999). Willingness to expand partnering results in an increase in the effectiveness of supply chain partnering (Rajagopal *et al.*, 2009), where both leveraging of external constraints and managing internal organizational behavior are necessary (Pfeffer and Salancik, 2003).

According to Moktadir *et al.* (2018), industry 4.0 increases production rates through smart technologies, advanced robotics and cloud computing, which, in turn, lead to producing better products at a lower cost. Cloud services facilitate real-time exchange of data, thus creating and promoting an environment characterized by digital collaboration and integration. A collaborative supply chain that applies cloud services and available information will be able to better provide real-time visibility, thus connecting key stakeholders and allowing organizations to proactively manage the supply chain (Tjahjono *et al.*, 2017) because cloud platform services make it possible to store and access data and to perform important tasks in real-time (Haleem and Javaid, 2019). For example, with a cloud SCM platform service, it is possible to increase data sharing across the complete manufacturing system between supply chain partners and also to analyze exchanged information and market trends from a customer perspective.

Collaboration with upstream suppliers has been shown to be closely linked with supply chain process performance, while collaboration with downstream customers has been shown to be more related to product performance (Vachon and Klassen, 2008). This suggests that effective SCM has become a value-adding method by which to gain a competitive edge and improve organizational performance (Kuei *et al.*, 2001). In this collaboration process, cloud services can be used for sharing information instantaneously and can limit the resources required to acquire information (Marston *et al.*, 2011) because such services enable firms to share their information promptly and efficiently, thus enhancing job performance and efficiency and adding to firm value (Lord *et al.*, 1995).

As cloud-based supply chain management (CSCM) provides the benefit of information sharing and communication across firm boundaries, it is possible to create supply chain networks (Steinfield *et al.*, 2011). A greater degree of willingness to engage in both internal and joint collaboration intended to enhance CSCM networks may lead to competitive advantage (Autry *et al.*, 2010). In addition, cross-organizational information and knowledge sharing is typically related to data involving production demand analyses, process planning and decision-making. This is the type of data that reduces risk and has a bullwhip moderating effect that improves operational management (Huang *et al.*, 2013). Further, prior studies have repeatedly shown that a key component of effective SCM is the flexibility it affords in terms of finding ways to meet customer needs (Swafford *et al.*, 2006).

The transparency of cloud SCM information enables supply chain partners to acquire vital information in a timely manner both upstream and downstream. Because the goal of SCM is to gain maximum value for customers, cloud technology allows partners to receive more prompt information related to customer needs than would otherwise be possible, and thus, improves organizational performance (Venters and Whitley, 2012). For example, cloud technology allows partners to receive more prompt information related to customer needs than would otherwise be possible, while in the case of the product data management system, oftentimes, the client-side will be web-based technology (Gao *et al.*, 2003). An enterprise resource planning system, on the other hand, has to handle multiple network connections because of the separate database and application servers (Yen *et al.*, 2002). Research has indicated that information sharing enables manufacturers to obtain a higher percentage of inventory reduction, and thus, reduce inventory costs (Lee *et al.*, 2000).

3. Research model

This study is based on a survey sent to managers of organizations in Taiwan that have implemented cloud-based supply management chains. The questions in the survey were based on concepts taken from the resource management theory. An analysis of the responses to these questions provides the perspectives of organizational managers on the degree to which internal resources and alignment with other firms affect the construction of CSCM systems and the way in which these factors result in improved cycle time performance and improve the performance of organizations as a whole.

4. Hypotheses

4.1 Internal cloud-based supply chain management resources

CSCM emphasizes cross-functional, inter-organizational coordination of activities intended to create competitive advantage (Sheth and Sharma, 1997; Ballou *et al.*, 2000). Prior studies suggest that communication, employee commitment and top-management commitment are predictors of CSCM project success (Brinkhoff *et al.*, 2015). Similarly, information technology sharing and human resource support are major internal SCM conditions necessary to improve SCM execution (Teller *et al.*, 2012). CSCM is affected not only by internal resources such as employee and managerial efforts and financial support but also is affected by collaborative goals related to stock, forecasting information and interaction with external supply chain partners. Consequently, this study is an attempt to assess the internal SCM resources used by the surveyed companies to implement their cloud chain management systems, including the firms' internal human resources and finances, top-management support, internally-launched goals related to their cloud SCM projects and their information technology skills. The measurement items were selectively adapted and modified slightly from a previous study by Teller *et al.* (2012) to make them compatible with the CSCM resource context.

H1. Internal CSCM resources must be positively related to joint cloud SCM conditions.

H2. Internal CSCM resources are positively related to the execution of CSCM.

4.2 Joint cloud supply chain management conditions

A successful supply chain is strongly dependent on the interaction relationship among supply chain partners (Wu *et al.*, 2013) because the building of mutual trust between partners is considered to play a central role in information system adoption (Lin and Chen, 2012). Therefore, the question of whether upstream and downstream manufacturers, customers, markets and consumers can trust each other and cooperate together and share the same goals significantly affects the execution of a common information system. It is this common information system that makes it possible for information departments to quickly detect, understand and flexibly respond to rapid changes in the external environment. In addition, supply chain integration performance is dependent on the ability to leverage information technology (IT) competence that can be effectively used by supply chain partners (Chakravarty *et al.*, 2013). Evidence of joint CSCM information sharing is an appropriate measure of supply chain collaboration. Evidence that a CSCM is sharing information related to inventory status and forecasts, that there is agreement on collaborative goals, a willingness to trust and the maintenance of long-term relationships with supply chain partners (Teller *et al.*, 2012) can be used to capture the status of joint CSCM conditions.

H3. Joint CSCM conditions are positively related to the execution of CSCM.

4.3 Implementation of cloud-based supply chain management

Effective cloud SCM information sharing requires a stable quality of information flow across companies, which is dependent on IT support efficiency (Cegielski *et al.*, 2012). Measuring the extent to which the implementation of CSCM leads to integration or coordination of various business territories within a company and among supply chain partners provides an assessment of IT support efficiency (Teller *et al.*, 2012;

Mentzer *et al.*, 2001). One of the purposes of this research is to determine how the linkages between resources and internal and joint cloud SCM conditions affect the execution of cloud SCM. This construct is assessed in terms the ability to forecast future customer needs, the adoption of the production capacity necessary to address customer demand, the incorporation of suppliers into the product development process and the integration of SCM processes with suppliers, customers and internal organizational SCM processes (Lambert *et al.*, 1998; Mentzer *et al.*, 2001).

H4. Execution of CSCM is positively related to organizational performance.

4.4 Supply chain management cycle time performance

As per Handfield and Nichols (2002), cycle time is operationalized to provide a direct linkage to company profit performance. This study was aimed toward determining the relational effectiveness of supply management processes in regard to the degree to which they help enhance cycle time performance and lead to competitive advantage (Chen *et al.*, 2004). Another major objective was to empirically examine the linkages between cloud SCM execution and time-based SCM cycle time performance. Hult *et al.* (2007) suggest that firms use the value of strategic SCM as a competitive weapon by which to gain advantages over other companies. Cycle time is a key indicator by which to examine supply chain functioning and more importantly, it directly links to a firm's market share and profit. Therefore, the respondents in this study were asked to rate their degree of agreement with the accuracy of statements about business process effectiveness related to cycle time performance. Consequently, six items measuring the cycle time performance were proposed, including the effectiveness of supply management process-related improvements, the shortening of cycle time, the speediness of the process and the partnerships making it possible to shorten the supply chain process (Ralston *et al.*, 2014).

H5. Joint cloud SCM conditions are positively related to SCM cycle time performance.

4.5 Organizational performance

Supply chain integration enhances the information transmission efficiency of firms within the supply chain system by reducing inventory costs and improving on-time delivery, thus positively impacting firm performance (Rai *et al.*, 2006; Sánchez and Pérez, 2005). As firm competition is no longer between firms but is now among supply chains, CSCM effectiveness ensures competitive advantage and improves company performance (Li *et al.*, 2006). CSCM strategies related to communication, trust and supply chain partners suggest that positive links between marketing and financial performance will develop (Green *et al.*, 2006). Organizational performance refers to how successful a firm is in meeting its market and financial targets (Qrunfleh and Tarafdar, 2015). Therefore, we measured firm performance through four types of achievement, namely, growth of market share, sales, return on investment and profit margin on sales (Li *et al.*, 2006). These measures have been widely used in previous studies because they are the primary criteria of concern to most stakeholders (Cao and Zhang, 2011). Cloud supply chain management systems assist in helping supply chain partners achieve effective, flexible, faster responses to changing market demands. Highly integrated supply chain relationships that provide the additional power necessary to enhance production planning capabilities and organizational performance should, thus, be reflected in a company's financial metrics.

H6. Execution of CSCM is positively related to SCM cycle time performance.

H7. CSCM cycle time performance is positively related to organizational performance.

H8. Internal CSCM resources are positively related to organizational performance.

H9. Join CSCM conditions are positively related to organizational performance.

5. Research methodology

5.1 Questionnaire design

A survey method was used for data collection and for testing the proposed model. A two-page, two-part questionnaire was used in this study. In the first part, a seven-point Likert rating scale was used, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). It was used to evaluate each of the measured constructs. The purpose of the second part was to collect the respondents' demographic information, including industry category, job title, education level, cloud SCM service usage experience and company size.

5.2 Measures

The construct definitions and items were modified slightly from those of previous studies to make them compatible with the CSCM context. The items used to measure internal and joint CSCM conditions and execution of CSCM were adopted and slightly modified from Teller *et al.* (2012). The SCM cycle time was slightly modified from Ralston *et al.* (2014). Finally, organizational performance was adopted from Li *et al.* (2006).

5.3 Factors studied

5.3.1 Internal cloud-based supply chain management resources

SCM emphasizes cross-functional, inter-organizational coordination of activities intended to create a competitive advantage (Sheth and Sharma, 1997; Ballou *et al.*, 2000). Prior studies suggest that within an organization, communication, employee commitment and top-management commitment are predictors of SCM project success (Brinkhoff *et al.*, 2015). Similarly, information technology sharing and human resource support are major internal SCM conditions necessary to improve SCM execution (Teller *et al.*, 2012). CSCM is affected not only by internal resources such as employee and managerial efforts and financial support but also is affected by collaborative goals related to stock, forecasting information and interaction with external supply chain partners. Consequently, this study captures the concept of internal SCM resources by examining a firm's most suitable and available internal human resources and finances, top-management support, evidence of internally launched goals for cloud SCM projects and abilities related to information technology. Such strategic goals and roles make the management of these firms more efficient and better able to allocate internal resources that can be of value to supply chain partners.

The internal support construct as it relates to execution of an SCM system depends on the level at which internal processes are used by suppliers and customers (Teller *et al.*, 2012). However, it may be defined differently, in other words, at the level of the "execution of SCM within organizations" instead of the execution of cloud SCM. Therefore, the measurement items were selectively adapted and modified from a previous study by Teller *et al.* (2012) to make them compatible with the CSCM resource.

The questions in the survey designed to learn the thoughts of the organizational managers under consideration concerning the internal conditions within their organizations and whether those conditions did or did not positively affect the implementation of a CSCM system were:

- [...] are personnel/human resources made available for CSCM issues?
- [...] are financial resources made available for CSCM issues?
- [...] does the top-management of your company support CSCM issues?
- [...] were internal goals set up before CSCM projects were launched?
- [...] are employees able to use IT-systems to address CSCM issues?

5.3.2 Joint cloud supply chain management conditions

The success of a firm's CSCM depends on the level of accuracy and the efficiency of the information offered by corporate partners, where information sharing in the supply chain is defined as proprietary information communicated exclusively among supply chain partners (Chong *et al.*, 2009). Collaboration in information technologies among supply chain stakeholders has become a key to achieving efficient supply chains (Zhou, 2009). As enterprises seek methods that can be used to create competitive advantages through the leveraging of the supply chain, CSCM has become a popular method by which to enhance information transparency and improve the quality of data exchanges between partners (Morgan and Conboy, 2013). Therefore, it is necessary to establish collaborative goals for the purpose of information sharing and obtaining accurate data to effectively implement cloud SCM. Leimeister *et al.* (2010) suggest that companies need to define rules and conditions for the sharing of information and also should incorporate the mutual interests of supply chain stakeholders prior to executing cloud SCM. This implies that the successful execution of cloud SCM requires specific input that incorporates collaborative goals, information related to stocking, forecasting and product development and also involves the building of a trust relationship within the joint cloud.

The questions in the survey designed to learn the thoughts of the organizational managers under consideration concerning joint cloud conditions affecting their organizations and whether those conditions did or did not positively affect the implementation of a CSCM system were:

- [...] is there agreement on collaborative goals with other supply chain members?
- [...] does your company exchange information regarding stock levels with other supply chain members?
- [...] does your company exchange forecasting information with other supply chain members?
- [...] is your company willing to trust other supply chain members?
- [...] does your company have long-term relationships with other supply chain members?

5.3.3 Execution of cloud-based supply chain management

Effective CSCM depends on a stable flow of quality information across companies. This is dependent on IT support efficiency (Cegielski *et al.*, 2012). In this study, a measure was developed to assess the extent to which CSCM service practices were able to integrate or coordinate various business territories within a given company and between supply chain partners (Teller *et al.*, 2012; Mentzer *et al.*, 2001). In this study, the terms "capable" and "integrated" are applied in the survey items related to CSCM execution to assess the degree to which a company has been able to implement a successful CSCM system. One of the purposes of this research is to determine how the linkages between resources and internal and joint cloud SCM conditions affect the execution of cloud SCM. This construct is assessed in terms of a company's ability to forecast future customer needs, its ability to create the production capacity necessary to address customer demand, the incorporation of suppliers into the product development process and the integration of SCM processes with suppliers, customers and internal organization SCM processes (Lambert *et al.*, 1998; Mentzer *et al.*, 2001).

The questions in the survey designed to learn the thoughts of the organizational managers under consideration related to the factors that affected the overall implementation of their cloud-based supply-based management systems as to whether these factors did or did not positively affect the implementation of the CSCM system were:

- [...] is your company capable of forecasting future customer demand for an CSCM system?
- [...] is your company capable of adapting production capacity on an CSCM system based on customer demand?
- [...] is your company capable of integrating key accounts into an CSCM system for the product development process?
- [...] is your company capable of integrating key accounts into an CSCM system in the development and implementation of marketing programs?
- [...] has your company integrated sourcing, logistics, marketing, product development and other areas on the CSCM system with your suppliers?
- [...] has your company integrated sourcing, logistics, marketing, product development and other areas on the CSCM system with your customers?

5.3.4 Supply chain management cycle time performance

Handfield and Nichols (2002) show that cycle time is directly connected to company profit performance. One of the aims of this study was to assess the degree to which supply management processes help enhance cycle time performance and lead to competitive advantage (Chen *et al.*, 2004). Another major objective of this study was to empirically examine the linkages between cloud SCM execution and time-based SCM cycle time performance. Cycle time is a key indicator of the quality of a firm's supply chain management and more importantly, of the link between CSCM and a firm's market share and profit. Therefore, the respondents in this study were asked to rate their degree of agreement with the accuracy of a number of statements relating to business process effectiveness and cycle time performance. Consequently, six items measuring cycle time performance were proposed, including the effectiveness of supply management process-related improvements, the shortening of cycle times, the speediness of the process and the partnerships that made it possible to shorten the supply chain process (Ralston *et al.*, 2014).

The statements in the survey designed to learn the thoughts of the organizational managers under consideration concerning the factors that affected SCM time performance and whether these factors did or did not positively affect the implementation of the CSCM system were:

- The length of the supply management process becomes shorter when CSCM is used.
- We have recently seen an improvement in the cycle time of the supply management process.
- We are satisfied with the speediness of the CSCM process.
- Involving the participants in CSCM with decision-making shortens the supply management process.
- Based on our knowledge of the supply management process, we think using CSCM is quick and efficient.
- The length of the supply management process could not be much shorter than it currently is.

5.3.5 Organizational performance

Supply chain integration enhances the information transmission efficiency of firms within the supply chain system by reducing inventory costs and improving on-time delivery, thus positively impacting firm performance (Rai *et al.*, 2006; Sánchez and Pérez, 2005). As firm competition is no longer between firms but is now among supply chains, SCM effectiveness ensures competitive advantage and improves company performance (Li *et al.*, 2006). The SCM strategy related to communication, trust and supply chain partners suggests there are positive links between marketing and financial performance (Green *et al.*, 2006). Organizational performance refers to how successful a firm is in meeting both its market and financial targets (Qrunfleh and Tarafdar, 2015). Therefore, we measured firm performance through four types of achievement, namely, growth of market share, sales, return on investment and profit margin on sales (Li *et al.*, 2006). These measures have been widely used in previous studies because they are the primary criteria of interest to most stakeholders (Cao and Zhang, 2011). Cloud supply chain management systems that help supply chain partners achieve effective, flexible, highly integrated supply chain relationships give those partners more power to enhance their production planning capabilities and improve the performance of their organizations. These results should be reflected in a company's financial metrics.

The factors in the survey designed to learn the thoughts of the organizational managers under consideration concerning the factors that affected overall organizational performance and whether these factors did or did not positively affect the implementation of the CSCM system were:

- The growth of market share.
- The growth of sales.
- Return on investment.
- Profit margin on sales.

5.4 Survey procedure

The questionnaire with its corresponding constructs was reviewed by five academicians and tested with five practitioners. Based on their feedback, any redundant or ambiguous items were either modified or deleted. The questionnaire was pretested by 30 senior managers who are skilled in the operation and management of supply chain systems. This questionnaire was then sent out to 1,000 top manufacturing enterprises in Taiwan.

5.5 Data collection

The target sample was obtained from the top 1,000 manufacturing enterprises in Taiwan (CommonWealth Magazine, 2015). Common wealth magazine was established more than 35 years ago and is reputed to be one of the leading political-economic magazines in Taiwan. It offers information on economic, political and social trends. To obtain the respondents for the current study, questionnaires were sent to administrators/managers in supply chain-related departments who were supply chain management leaders and had the appropriate level of knowledge about the level of integration in their supply chain and the degree to which their company interacts regularly with competitors, customers or suppliers. The final version of the questionnaire, a cover letter, the survey and a self-addressed envelope were sent via mail. Three weeks afterwards, reminder phone calls were made to all potential respondents. In total, 243 surveys were received; 9 were returned because of address discrepancies and 11 were discarded because of incomplete data, yielding 223 (22.3%) usable questionnaires.

Among the 223 surveys, 223 (100%) respondents were used in manufacturing firms with over 200 employees. The majority (52.1%) had a bachelor's degree and 38.6% had graduate degrees. Approximately 52% worked in administration; sales and purchasing employees comprised 22.0% and 24.7%, respectively and the remaining 1.3% held similar positions. Among the study sample, 67.6% had a branch company overseas (42% in China) (Table 1).

The method proposed by Armstrong and Overton (1977) was used to test for nonresponse bias. One viable check for the study construct was examined by splitting the survey sample into early (within 30 days; $n = 138$) and late respondents (past 30 days; $n = 85$). A comparison between these two groups revealed that there were no significant differences in the subjects' demographic profiles. We also examined differences between the with and without overseas branch groups. A *t*-test on the constructs of the study showed no significant between-group differences (Table 2).

6. Data analysis and hypothesis testing

Structural equation modeling (SEM) was applied to test the study model and examine the internal consistency and

Table 1 Demographic data for the sample

Attributes	Categories	Frequency	(%)
Work experience	One year+	43	18.2
	Three years+	81	34.3
	Five years+	66	28
	Ten years+	37	15.7
	Other	9	3.8
China branch	Yes	94	42.2
	No	129	57.8
Overseas branch	Yes	133	67.6
	No	90	33.4
Job title	Administration	116	52.0
	Sales	49	22.0
	Purchaser	52	24.7
	Other	3	1.3
Educational level	Graduate school	60	25.4
	University	123	52.1
	College	34	14.4
	High school	19	8.1
	Other	0	0

Table 2 Descriptive statistics between with or without branch company in oversea

	Oversea		Non-oversea		*t*-test	
Construct	**Mean**	**SD**	**Mean**	**SD**	***t***	**Sig.**
Internal CSCM	5.48	0.65	5.38	0.63	0.91	0.69
Joint CSCM	5.37	0.60	5.26	0.66	0.95	0.48
Execution of CSCM	5.44	0.59	5.31	0.49	1.28	0.16
Cycle time performance	5.21	0.48	5.19	0.55	0.19	0.25
Organizational performance	5.11	0.62	5.04	0.73	0.58	0.32

discriminant validity of the constructs. A confirmatory factor analysis (CFA) and a regression analysis were used to model the various relationships (Anderson and Gerbing, 1988). A CFA was conducted using Analysis of MOment Structures (AMOS) to test for convergent and discriminant validity.

6.1 Measurement model

First, convergent validity (Table 3) was evaluated using the three criteria suggested by Fornell and Larcker (1981). As indicated in Table 1, all the factor loadings statistically surpassed the required minimum of 0.60, which is the minimum amount needed to ensure the convergent validity of a construct (Anderson and Gerbing, 1988). Secondly, the average variance extracted (AVE) for each construct reached more than 0.50, indicating that the nine hypotheses accounted for more variance in the underlying construct than that attributable to measurement error (Fornell and Larcker, 1981). Thirdly, the reliabilities for each construct exceeded 0.70, confirming acceptance of the reliability of these research instruments. The composite reliability (CR) for the latent variables exceeded 0.70, which surpassed the recommended CR value for each construct, suggesting good reliability (Hair, 1998). Collectively, the analyzed data of this research met all three criteria required to assure convergence.

Fornell and Larcker (1981) questioned whether the AVE for each construct greater than the square of the correlation between the constructs should be examined. Discriminant validity was, therefore, investigated to generate cross-loading information on the other constructs. If the value of the square root of the AVE for each construct is higher than its shared variance with any other construct, then discriminant validity is supported (Gefen and Straub, 2005). In our study (Table 4), the largest correlation in the construct was 0.65 [cycle time (CT) and organization (ORG)], which was less than the smallest square root of the AVE (0.71) (EXT). Because the AVE for each construct was greater than the squared correlation between that construct and each of the other constructs, the discriminant validity in our study was supported (Hair, 1998; Zacharia *et al.*, 2011).

6.2 Structural model

SEM was applied to test the research model and examine the internal consistency and discriminant validity of the constructs. An AMOS structural model assessment indicated that the results of the CFA estimation of the five constructs had acceptable goodness of fit (goodness of fit index (GFI) = 0.90; adjusted goodness of fit index (AGFI) = 0.88; comparative fit index (CFI) = 0.98; root mean square error of approximation = 0.028), thus supporting model stability (Anderson and Gerbing, 1988). The overall model fit, as indicated by the $\chi 2$ statistic (X^2 = 306.66, df = 261, $p < 0.01$) value of 1.17, was less than the 3.00 maximum value recommended by Kline (1998). Figure 1 presents the result of the AMOS structural model assessment with the estimated path coefficients and the associated *t*-values of the path. As shown in Figure 2 and Table 5, except for hypotheses *H2* and *H8*, all other study hypotheses were supported by the standardized estimates and associated *p*-values.

6.3 The mediating role of execution of cloud-based supply chain management

Because the execution of CSCM might be one of the most important predictors of organizational performance and cycle time performance, we further examined mediation effects beyond the prior analysis using the SEM. Figure 2 presents the overall conceptual framework for mediation and describes the proposed relationships among internal and joint cloud supply chain factors, the execution of the cloud supply chain system and cycle time and organizational performance. Specifically, this study hypothesizes that construction of a cloud supply chain mediates the influence of internal and joint cloud supply chain factors on cycle time and organizational performance. These relationships are consistent with Chen *et al.*'s (2004) observation of the collaborative relationship between supply chain partners as they relate to managers' cognitive responses toward external issues facing their firms. The impact of the creation of a cloud supply chain system on performance can be seen in the emergence of cooperative strategies that rely on mutual relationships between internal and joint factors. It is believed that an empirical examination of these proposed relationships will enhance the limited amount of prior research on cloud supply chain orientation. As highlighted earlier, prior researchers have often omitted the performance implications of organizational orientation from their analyses (Shacklett, 2010)

Table 3 Convergent validity

Constructs	Indicators	Standard factor loadings	Item reliability Standard errors	*t*-value	CR	AVE
Internal CSCM resource	INT_1	0.72	0.48	$t > 9$	0.84	0.52
	INT_2	0.60	0.64			
	INT_3	0.79	0.37			
	INT_4	0.73	0.47			
	INT_5	0.74	0.45			
Joint CSCM condition	JIN_1	0.73	0.46	$t > 9$	0.83	0.50
	JIN_2	0.68	0.55			
	JIN_3	0.76	0.42			
	JIN_4	0.68	0.53			
	JIN_5	0.69	0.53			
CSCM execution	EXC_1	0.77	0.41	$t > 9$	0.87	0.53
	EXC_2	0.86	0.26			
	EXC_3	0.70	0.51			
	EXC_4	0.69	0.52			
	EXC_5	0.68	0.53			
	EXC_6	0.66	0.57			
CSCM cycle time	CT_1	0.78	0.39	$t > 9$	0.87	0.54
	CT_2	0.77	0.41			
	CT_3	0.84	0.30			
	CT_4	0.74	0.46			
	CT_5	0.61	0.63			
	CT_6	0.64	0.58			
Organizational performance	ORG_1	0.76	0.42	$t > 10$	0.86	0.60
	ORG_2	0.80	0.36			
	ORG_3	0.85	0.28			
	ORG_4	0.68	0.53			

Table 4 Discriminant validity

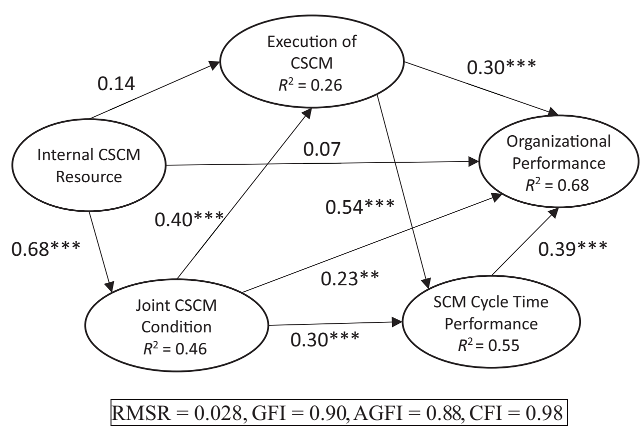
Constructs	INT	JIN	EXC	CT	ORG
INT	0.72				
JIN	0.55	0.71			
EXC	0.36	0.43	0.73		
CT	0.43	0.44	0.61	0.73	
ORG	0.46	0.53	0.64	0.65	0.78

Note: Square root of AVE is shown on the diagonal of the matrix

or have simply examined the degree of success of the collaboration relationship among supply chain partners (Chen *et al.*, 2004).

As discussed by Baron and Kenny (1986), firstly, the independent variables (i.e. the internal and joint CSCM conditions) should be associated with the dependent variables (i.e. organizational performance and cycle time). Second, the independent variables are required to have a genuinely significant relationship with the mediator variable (i.e. execution of CSCM). Third, the mediator variable should be tightly connected to the dependent variable. Finally, the inclusion of the mediator variable should result in either a partial or full crowding out of the direct effects of the independent variables on the dependent variable determined after solving the second equation. As shown in Figure 3, the results indicate that execution of CSCM served as a mediator between internal CSCM resources and joint CSCM conditions as an independent variable and organizational performance and cycle time served as a dependent variable (Figure 2).

Figure 1 Results of the proposed research model



Notes: $^{**}p < 0.05$; $^{***}p < 0.01$

7. Results

The results after executing Step 1 revealed that in Models 1-3, internal CSCM resources and joint CSCM conditions

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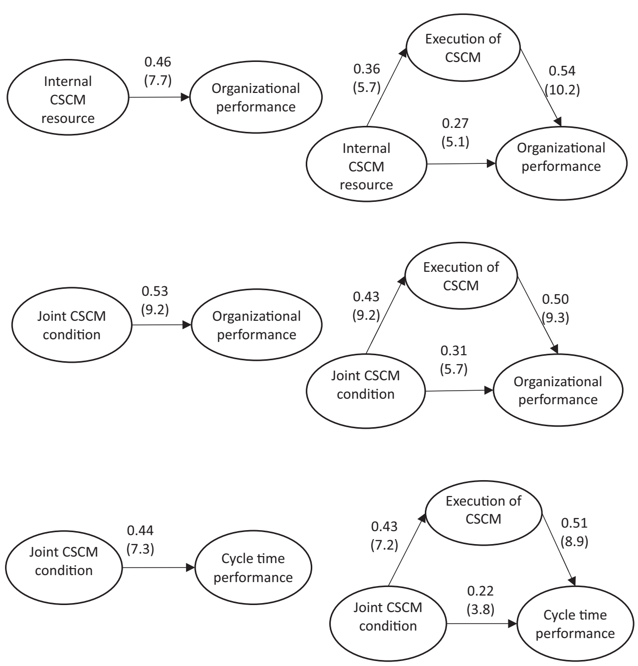
positively predicted organizational performance (β = 0.46, $p < 0.01$; β = 0.53, $p < 0.01$, respectively) and SCM cycle time performance (β = 0.44, $p < 0.01$). The results for Step 2 indicated that both internal CSCM resources and joint CSCM conditions positively affected execution of CSCM (β = 0.36, $p < 0.01$; β = 0.43, $p < 0.01$; β = 0.43, $p < 0.01$, respectively). The results for Step 3 showed that the standardized coefficient estimates for internal CSCM resources and the effects of execution of CSCM on organizational performance were significant (β = 0.27, $p < 0.01$; β = 0.54, $p < 0.01$). Similarly, the joint CSCM conditions and the effects of execution of CSCM on organizational performance (β = 0.31, $p < 0.01$; β = 0.50, $p < 0.01$) and joint CSCM conditions and the effect of execution of CSCM on SCM cycle time performance (β = 0.22, $p < 0.01$; β = 0.51, $p < 0.01$) were also significant. These empirical results indicate that the impact of internal CSCM resources and joint CSCM conditions on organizational performance was partially mediated by the execution of CSCM. Similarly, the impact of joint CSCM conditions on SCM cycle time performance was partially mediated by the execution of CSCM.

Figure 2 Mediation test with standardized estimates and (*t*-values), Models 1–3



We also conducted a bootstrap test and a bootstrap confidence interval (bias-corrected and percentile method), as bootstrapping is one of the more reliable methods for testing intervening variable effects (Hayes, 2009) and then ran the mediating model again. With regard to the total effect of internal CSCM resources and joint CSCM conditions on organizational performance, the standardized total effect values were 0.597 (Z = 6.49) and 0.636 (Z = 6.56), respectively, whereas the effect of joint CSCM conditions on SCM cycle time performance was 0.492 (Z = 5.93). For the indirect effects of internal CSCM resources and joint CSCM conditions on organizational performance in the presence of mediating variables, we found that the standardized indirect effect values were 0.258 (Z = 4.03) and 0.260 (Z = 4.48), respectively, whereas the effect of joint CSCM conditions on SCM cycle time performance was 0.248 (Z = 3.70). For the direct effects of internal CSCM resources and joint CSCM conditions on organizational performance, we found the standardized direct effect values to be 0.340 (Z = 4.42) and 0.376 (Z = 4.53), respectively, whereas the effect of joint CSCM conditions on SCM cycle time performance was 0.244 (Z = 3.17). The results of the β coefficient are summarized in Table 6. In summary, the effect of the execution of CSCM on SCM cycle time and organizational performance was shown to be significant in all three models. The findings showed that internal CSCM resources and joint CSCM conditions are key predictors of the execution of CSCM, while execution of CSCM only partially impacts SCM cycle time and organizational performance.

8. Discussion and implications

8.1 Discussion

The proposed model highlighted the importance of considering RDT when exploring the relationships among the factors involved in the execution of cloud SCM, cycle time and organizational performance. The key factors affecting the execution of cloud SCM systems in terms of achieving effective SCM cycle times and organizational performance were empirically tested. A cloud SCM system is designed to assist a supply chain in forecasting and adapting to customer demand, integrating key account information into product development and marketing programs and integrating sourcing, logistics and marketing with suppliers and customers.

The research results show first that a firm's cloud supply chain resources have significant effects on joint cloud SCM conditions. The findings on collaboration between supply chain partners can be identified as a core antecedent driving the

Table 5 Results for proposed structural equation model

Hypothesis	Relationship	Total effects	Direct effects	Indirect effect	Hypothesis
H1	INT → JIN	0.68	0.68		Supported
H2	INT → EXC	0.41	0.14	0.27	Non-significant
H3	JIN → EXC	0.40	0.40		Supported
H4	EXC → ORG	0.51	0.30	0.21	Supported
H5	JIN → CT	0.52	0.30	0.22	Supported
H6	EXC → CT	0.54	0.54		Supported
H7	CT → ORG	0.39	0.39		Supported
H8	INT → ORG	0.51	0.07	0.44	Non-significant
H9	JIN → ORG	0.55	0.23	0.32	Supported

Table 6 Results of the bootstrapping test

Path effect	Point estimates	SE	Z	Bias-corrected 95% C.I. Lower	Bias-corrected 95% C.I. Upper	Percentile 95% C.I. Lower	Percentile 95% C.I. Upper
INT → EXC → ORG							
Total effects	0.597	0.092	6.49	0.427	0.786	0.427	0.784
Indirect effects	0.258	0.064	4.03	0.155	0.410	0.148	0.398
Direct effects	0.340	0.077	4.42	0.193	0.497	0.189	0.492
JIN → EXC → ORG							
Total effects	0.636	0.097	6.56	0.468	0.854	0.464	0.851
Indirect effects	0.260	0.058	4.48	0.173	0.401	0.164	0.391
Direct effects	0.376	0.083	4.53	0.227	0.558	0.221	0.553
JIN → EXC → CT							
Total effects	0.492	0.083	5.93	0.345	0.674	0.343	0.673
Indirect effects	0.248	0.067	3.70	0.145	0.408	0.143	0.404
Direct effects	0.244	0.077	3.17	0.088	0.394	0.086	0.391

execution of CSCM. This is supported by the research of Teller *et al.* (2012). Joint cloud SCM is viewed as potentially having a considerable impact on the execution of a cloud SCM system and should be viewed as a crucial factor and this should affect the way in which adoption of a cloud SCM system is considered. It is recommended that managers study how internal resources and joint cloud conditions can be applied to the execution of CSCM system applications. They should also determine which aspects of the cloud supply chain system and what future improvements can be incorporated into their supply chain management as a value-added service, and thus, in turn, contribute to SCM cycle time effectiveness. By doing this, they can gain competitive advantages and improve organizational performance.

Some studies have found that organizational performance is mostly driven by competition between supply chains [Leuschner *et al.* (2013) and Moyano-Fuentes *et al.* (2016)] and internal cloud SCM resources have not been found to have a direct impact on the execution of cloud SCM or organizational performance. This may imply that the successful execution of cloud SCM requires inputs related to collaborative goals and the sharing of information related to stocking, forecasting, product development and the trust relationship stemming from joint cloud SCM conditions. This concurs with the research of Leimeister *et al.* (2010), who suggest that companies should define rules and conditions while incorporating the interests of both internal and joint supply chain stakeholders in the execution of cloud SCM. The findings in this study suggest that it is important that companies wishing to implement effective cloud SCM systems set up collaborative relationships among internal cloud SCM sources and establish excellent joint cloud SCM conditions to support the execution of cloud SCM in a way that will improve business performance.

Further, the mediating effect of CSCM between internal and joint CSCM conditions on SCM cycle time and organizational performance revealed that CSCM advantages strongly depend on the relationships among supply chain collaboration conditions. This implies that a firm with well-designed joint conditions is more likely to be successful in implementing an effective cloud SCM system. The finding is not surprising because production scheduling depends heavily on monitoring production schedules and demand forecasts from customers and suppliers. The execution of cloud SCM should increase flexibility and make it easier to manage production in ways that will improve productivity (Xu, 2012).

The analyses conducted in this study positively supported the presence of the effects of joint cloud SCM conditions and the execution of cloud SCM on SCM cycle time performance and organizational performance. The tactical benefits derived from the execution of cloud SCM are the most important factors leading to improved SCM cycle time and better organizational performance. Firms planning to implement cloud technology in their supply chain should leverage both internal and joint resources that will facilitate appropriate competitive activities within their supply chain (Chen *et al.*, 2004). Based on these results, it can be strongly inferred that cloud SCM can serve as a pivotal means by which to mediate the full cause-effect construct that will strengthen coordination and cooperation and create a win-win situation for supply chain partners that, in turn, will improve SCM cycle time and organizational performance.

8.2 Execution of cloud supply chain management in business-to-business managerial implications

When managers face supply chain management difficulties, research indicates that they should focus on investing strategic marketing and supply chain management capabilities such as innovativeness, market learning capability, supply chain agility and relational capability (Golgeci and Gligor, 2017). In addition, IT-based supply chains are a key factor related to improving new product development activities. With a supply chain structure based on IT, manufactures and suppliers can communicate in detail and respond quickly, which, in turn, results in lower costs (Kou *et al.*, 2018) in real-world cases, where there is a long supply chain, which has prevailed recently because of globalization, regardless of geographical or cultural distances. Companies, thus, mitigate the risks they face by developing connectivity within the supply chain that includes information that can be used mainly as a supportive tool (Engelseth and Wang, 2018).

From a managerial perspective, the study provides enlightening insights into the way that execution of cloud SCM may revolutionize the traditional SCM system, thus upgrading and transforming SCM in a way that will reduce costs and the time spent on information transfer while at the same time enhancing flexibility and effectiveness and improving performance. Managers may want to use a cloud SCM system to exploit their relative strengths within a group of supply chain partners as compared to their competitors. They need to consider how they can use their internal resources and joint conditions to integrate their upstream and downstream suppliers, to make necessary information transparent and to create a smooth flow in the cloud SCM system so that they can create a flexible, timely, efficient supply chain information system. Prior research also suggests that sharing helpful information and resources and maintaining regular contact reduces frustration and encourages joint value creation in communication by increasing trust in supply chain relationships (Kemp *et al.*, 2018).

The results of this study have a number of implications for research. First, internal resources exhibit a relatively stronger influence on conditions leading to execution of joint cloud SCM as compared to organizational performance. These findings indicate that although firms face intensive competition in markets, supply chain managers may be able to retain advantages if they take advantage of the critical factors that help establish and maintain favorable collaborative relationships with suppliers and consumers. Cloud supply chain system providers should provide their customers with mechanisms that enhance their execution of cloud SCM services within the supply chain partner context to build and integrate effective information processes that can potentially lead to higher levels of collaborative functions on the part of supply chain partners. For example, smartphone apps provide interaction with colleagues, can be used for time management and can be used to initiate specific manufacturing production activities. These mechanisms may include dynamic inventory or production scheduling for the purpose of online verification of the production activities taking place in a cloud SCM system among supply chain partners and making it easier to adjust the production schedule and capacity and to overcome the impact of the bullwhip effect. This will, in turn, shorten lead time and improve organizational performance.

Second, cloud SCM service providers can develop rating systems for information related to the credibility and integrity of suppliers. These rating systems can help firms reduce the risk of perceived uncertainty and risks associated with suppliers and other participants, thereby facilitating the development of trusting, collaborative relationships among supply chain partners and enhancing the effects of cloud SCM on organizational performance. A cloud SCM system may also include discussion forums that facilitate the online exchange of information among supply chain partners that leads to a better understanding of what suppliers and customers need based on their feedback. This knowledge may help firm managers respond to this feedback effectively and, in turn, enhance favorable relationships among supply chain partners. The research results also indicate that the effects of cycle time performance on organizational performance can be enhanced if the formation of internal cloud SCM, joint cloud SCM conditions and execution of cloud SCM are effectively managed. Thus, it is necessary for cloud SCM service providers to implement strategies that facilitate the development and maintenance of collaborative relationships that improve cycle time performance.

Finally, confirmation of the importance of high information quality and system quality highlights the importance of cloud SCM systems that are capable of providing supply chain partners with reliable, convenient system functions, quality information and up-to-date system-related services. These services can be provided by complying with critical system design features, including an interactive system design and the provision of customized information and system-related services. Well-designed CSCM systems can enhance the competitive advantage of firms by minimizing the uncertainty and risks that may arise among supply chain partners concerned about the operational complexity, convenience, reliability and trustworthiness of cloud SCM processes.

9. Limitations and future research

The results of this research revealed several limitations that should be noted. First, we only surveyed a single respondent from each participating company related to their perspectives on the effects of cloud computing service on SCM issues. Although a majority of the respondents worked in supply chain-related departments, it is rare for one person in a firm to be in charge of all supply chain activities. As the data collected in the survey was self-reported, it is possible that some of the respondents may not have had integrated supply chain management experience as a whole and may not be using the system as required. In addition, the findings indicated that the structural relationships held across the group of top 1,000 manufacturing firms in Taiwan, but the interrelationships between the relational responses of the supply chain partners and the production goals of the focal firms appeared to differ. There may be other methods and factors beyond those considered in this study that can be studied in future research in terms of their impact on organizational performance such as digital transformation business models. In addition, the results of this study are restricted to respondents in Taiwan, so the empirical results might not fully represent such phenomena elsewhere, especially in Western countries.

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