Evaluating the guanxi and supply chain collaborative transportation management in manufacturing industries

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Abstract: Manufacturing firms can facilitate their shipping and logistics operations via cooperation by adopting collaborative supply chain transportation. Moreover, in Chinese culture, guanxi is considered crucial for fostering close partnerships. This study empirically examines the relationships between supply chain information integration (SCII), collaborative transportation management (CTM) through interaction and collaboration between trading partners and carriers (supply chain CTM), logistics performance, and guanxi in manufacturing industries. In total, 152 usable responses from the manufacturing industry were collected using a questionnaire. A structural equation model (SEM) was used to evaluate the hypotheses. The results indicate that SCII is significantly positively related to supply chain CTM and logistics performance. While supply chain CTM is significantly positively related to logistics performance for manufacturing firms, guanxi has a significant moderating effect between SCII and supply chain CTM. The moderating effect of guanxi on manufacturing firms' supply chain CTM and logistics performance was not found in this study.

Keywords: supply chain information integration; SCII; collaborative transportation management; CTM; guanxi, moderating effect; structural equation modelling; SEM.

Reference to this paper should be made as follows: Lai, P-L., Kao, J-C., Yang, C-C. and Zhu, X. (2022) 'Evaluating the guanxi and supply chain collaborative transportation management in manufacturing industries', *Int. J. Shipping and Transport Logistics*, Vol. 15, Nos. 3/4, pp.435–458.

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This paper is a revised and expanded version of a paper entitled 'The values of collaborative transportation management in Taiwan's manufacturing industry: the moderating effect of Guanxi' presented at IAME 2017, Kyoto Japan, 27–30 June 2017.

1 Introduction

In this era of globalisation, competition between businesses has gradually transitioned to competition between supply chains in a dynamic marketplace. The question of how to manage a supply chain effectively has become an essential factor affecting competitive advantages. A supply chain involves a series of activities associated with the flows of goods and services and information from raw material preparation to end-users, including procurement, production, marketing, logistics system management, warehousing, and storage management, transportation, returns, and customer services (Murphy and Wood, 2008). Considering that supply chain activities involve numerous organisational partners, enterprises must establish long-term relationships with their supply chain partners to effectively enhance the overall supply chain performance. In particular, the integration and cooperation among supply chain partners contribute to a reduction in operational costs and improvement in customer service. They further contribute towards enhancing the overall supply chain competitiveness.

To make quick and effective decisions in this dynamic and changing marketplace, enterprises must obtain instant information about their customers, suppliers, and competitors (Cegielski et al., 2012; Seo et al., 2016). Both intra-organisational and extra-organisational information integration can be employed to alleviate uncertainty in supply chain processes and improve cooperation and information sharing between supply chain partners (Closs and Savitskie, 2003). Dhening et al. (2007) asserted that information integration contributed to collaborative supply chain management combining logistics, information flow, and cash flow to facilitate information and asset circulation between supply chain partners. Integrating and sharing information between supply chain partners is, thus, a crucial strategy for enhancing competitive advantages (Lai et al., 2020; Chang et al., 2021).

In addition, supply chain management schemes generally focus on information integration between related partners to shorten the distances between them (Lai et al., 2020). This facilitates the development and adoption of collaborative management in supply chains. A collaborative management model in the supply chain primarily comprises information sharing, followed by collaboration in decision-making, product planning, site location, and coordination in planning the transportation (Premkumar, 2000; Um and Kim, 2019). This scheme focuses on cooperation between businesses, promoting coordination and trust between them, and thereby increasing the overall efficiency and competitive advantages of the supply chain. Furthermore, the model requires upstream and downstream partners to coordinate and make decisions together instead of following a single business, leading to an increase in the overall supply chain performance. Thus, supply chain partners increase the frequency of information exchange to understand the related upstream and downstream businesses, maintain favourable relationships with one another, improve information-sharing processes, and thereby attain the goal of collaborative decision-making (Lai et al., 2020). With the development of collaborative supply chain management, a novel scheme, namely, collaborative planning forecasting and replenishment (CPFR), has been executed to reduce inventory costs and improve performance. However, the collaboration between shippers and carriers in the transportation and distribution fields has seldom been explored (Esper and Williams, 2003; Chan and Zhang, 2011). Therefore, one of the objectives of this research is to identify the collaborative relationship between shippers and carriers.

The purpose of collaborative transportation management (CTM) is to alleviate the flaws in supply chain transportation processes via information sharing and collaborative management, thereby improving the managerial performance of related partners (Chan and Zhang, 2011). To successfully implement the CTM initiative, shippers and carriers must integrate the information of a supply chain that involves linking intra-organisational and extra-organisational information, attain information sharing between supply chain members, and facilitate information transparency (Closs and Savitskie, 2003; Wong et al., 2015). Notably, guanxi is an essential indicator of trust, communication, commitment, and cooperation achieved via SCII. Guanxi is a cultural characteristic that has strong implications for interpersonal and inter-organisational dynamics in society (Park and Luo, 2001). Previous studies have frequently investigated business cooperation and partnership from a relationship perspective and rarely examined the effect of guanxi on supply chain management, primarily focusing on the risk relationship and trust levels between supply chain members (Cheng, 2011; Zhu and Lai, 2019; Geng et al., 2020), which are considered crucial for information sharing in a supply chain.

Numerous studies have addressed supply chain collaboration issues (Cao and Zhang, 2010; Kim and Lee, 2010; Guilherme et al., 2019; Jimenez-Jimenez et al., 2019; Lai et al., 2020). Though a few studies in the field of supply chain research have been focused on CTM, even fewer studies have examined the value of CTM from guanxi's perspective. Most studies have applied mathematical models to deal with the supply chain collaboration issues (Chan and Zhang, 2011; Li and Chan, 2012; Zhang et al, 2017; Chabot et al., 2018). CTM has drawn attention in the field of supply chain research. However, most studies have applied mathematical models (Chan and Zhang, 2011; Li and Chan, 2012; Zhang et al, 2017; Chabot et al., 2018) to deal with this issue, and a few studies have examined the value of CTM from guanxi's perspective.

Through integration and cooperation, manufacturing firms can facilitate shipping operations by adopting collaborative supply chain transportation. They can improve logistics performance and enhance the overall competitiveness of the supply chain. Moreover, in Chinese culture, guanxi is viewed as crucial for forging close partnerships in Chinese culture. Therefore, this study evaluates the relationships among SCII, supply chain CTM, logistics performance, and guanxi in the Taiwanese manufacturing industry.

One of the two contributions of this study is that it evaluates the impacts of supply chain information integration and CTM practices on logistics performance from the perspective of guanxi, particularly the Chinese culture. Specifically, the value of CTM practices in the manufacturing industry has been examined. Given that guanxi plays a crucial role in facilitating interactions and collaborations among supply chain partners, it is imperative for manufacturing firms must to build guanxi networks with partners when undertaking collaborative activities in adopting logistics collaboration activities. The other contribution of this study is that guanxi has been treated as a moderating variable in the logistics collaboration model.

The remainder of this paper proceeds as follows. Section 1 describes the background, motivation, and objectives of the study. Prior studies related to SCII, supply chain CTM, logistics performance, and guanxi literature are reviewed in Section 2. The research model and hypothesis development are subsequently described. Section 3 introduces the analytical methods including the design of the questionnaire, sample selection, and data analyses. The data analysis results are explained in section 4. The final section presents the findings, managerial implications for manufacturing firms, and directions for future study.

2 Literature review and research hypotheses

2.1 Supply chain information integration (SCII)

For efficient supply chain management, it is imperative for an organisation to cooperate with its upstream and downstream business partners along the supply chain. In particular, suppliers, internal processes, and customers must be linked and integrated to facilitate the smooth inflow and outflow of information and goods/services (Flynn et al., 2010; Wong et al., 2011). Facing an open system, organisations must process business-related information to reduce their uncertainty in decision-making (Daft and Lengel, 1986; Lai et al., 2020). Thus, information integration is an essential strategic requirement for business units and supply chain partners (Lee et al., 2007; Seo et al., 2016).

Information technology has been proven to have an indirect impact on competitive advantage (Chang et al., 2021). An effective information system or platform can enhance the SCII, which in turn, facilitates coordination and information sharing along the supply chain (Kulp et al., 2004; Wong et al., 2015). Leuschner et al. (2013, p. 38) defined supply chain information integration as 'the coordination of information sharing/transfer, collaborative communication, and supporting technology across firms in a supply chain'. This definition indicates that supply chain information integration involves linking intra- and extra-organisational information for exchanging information and communicating with partners along the supply chains. Studies have shown that well-integrated supply chain information enables organisations to share timely and accurate logistics information across internal and external organisational functions, which, in turn, enhances logistics performance (Bernstein and Hass, 2008; Shou et al., 2018; Lai et al., 2020). The linkages along the supply chains typically include internal and external linkages. The latter are composed of supplier and customer linkages (Flynn et al., 2010; Wong et al., 2011). Thus, internal information integration spans department boundaries and facilitates timely and accurate communication of logistics information across functional units of organisations (Wong et al., 2011). In contrast, external information integration involves suppliers and customers and reaches beyond organisational boundaries to accelerate information sharing among business partners along the supply chain (Gimenez and Ventura, 2005; Zhao et al., 2011; Wong et al., 2011).

2.2 Collaborative transportation management

Supply chain collaboration attempts to integrate supply chain partners and improve long-term performance by considering partners as a single entity. It has been treated as a crucial enabler for improving overall supply chain performance (Kim and Lee, 2010; Cao and Zhang, 2010; Seo et al., 2016). Typically, supply chain collaboration can be divided into systematic collaborations and strategic collaborations. A systematic collaboration is further divided into information sharing between partners, relationship integration between organisations, and estimation and planning of operations. Strategic collaboration is further divided into partner relationships and close cooperation (Kim and Lee, 2010). In general, common supply chain collaboration practices include information sharing, risk and resource sharing, collaborative planning, collaborative decision-making, collaborative operation, collaborative planning, and collaborative transportation (Premkumar, 2000; Tyan et al., 2003; Cao and Zhang, 2010; Um and Kim, 2019).

CTM is an extension of the collaborative planning, forecasting, and replenishment (CPFR) framework proposed by the Voluntary Interindustry Commerce Standards (VICS) Association (Esper and Williams, 2003; Wen, 2012). According to the VICS (2004), CTM is defined as a holistic process that integrates all supply chain partners to resolve the inefficiencies of transportation processes. Thus, it is a novel supply chain management strategy and an innovative business model that incorporates carriers as strategic partners to cooperate and share information with their partners in the supply chain. This is done through the collaboration among supply chain partners and carriers in the activities fields of creating a joint business plan, forecasting orders, generating orders, freight order confirmation, and scheduling process, and carrier payment process. Enterprises can avoid transportation and distribution inefficiencies, and, thereby improve their supply chain performance (Wen, 2012).

The implementation of CTM is aimed at developing collaborative relationships among shippers, carriers, and third-party logistics providers to improve transportation services and reduce costs along the supply chain (Esper and Williams, 2003). Feng and Yuan (2007) asserted that the CTM involves three constructs: relational integration, collaborative integration, and IT integration. Relational integration assesses the extent of cooperation, such as the scope of cooperation, goals, responsibilities, strategic information, and a long-term and trustworthy cooperative relationship. The collaborative forecasting construct pertains to the supply chain partners' capabilities to predict and plan, such as collaborative transportation planning, collaborative transportation decision-making, and transportation activity management. Finally, the IT integration construct evaluates the inter-organisational and interdepartmental information-sharing capabilities, which reflects how information exchange can effectively be used to establish a logistics transportation plan. Wen (2012) noted that the CTM practices also included collaborative planning, information integration, and relationship integration. Aharonovitz et al. (2018) pointed out that transportation- and logistics-related collaborations basically include joint creation of logistics projects, joint planning of vehicle requests, joint involvement of both teams in logistics processes, sharing of destination data, sharing of information on demand forecast, vehicle needs, and so on.

2.3 Logistics performance

By measuring the extent to which business objectives are achieved, performance measurement shows whether the resource allocation has been efficient. Typically, both hard and soft performances are common indicators used to measure performance (Venkatraman and Ramanujam, 1986). With the development of logistics and supply chain management, logistics performance has been treated as a key indicator of firms' organisational performance. Bowersox et al. (1999) used customer service, cost, quality, productivity, and asset management to measure logistics performance. In the supply chain operations reference (SCOR) model, five indicators, namely, reliability, responsiveness, flexibility, costs, and asset management are utilised to measure the logistics performance of firms.

To measure the logistics performance, Green et al. (2008) used speed, reliability of delivery, flexibility of delivery, responsiveness, and order fill capacity. Ruamsook et al. (2009) noted that on-time receipt, cycle-time consistency, cycle-time length, accurate quantity and selection, safety stock levels, accurate invoice, damage during delivery damage, product price, and transportation cost are important criteria for logistics performance measurement. Recently, Aharonovitz et al. (2018) found that supplier selection, the history of meetings, and relationships history had a positive effect on logistics collaboration. Logistics collaboration, in turn, positively impacted logistics performance, such as lead time, on-time delivery, error-free delivery, returned order rate, and so on. Wang (2018) pointed out that supply chain uncertainty and risk negatively impact logistics performance in terms of customer service, delivery operations, freight safety, and information accuracy.

To summarise, cost, time, reliability, responsiveness, and flexibility are common indicators used to measure logistics performance in the supply chain (Green et al., 2008; Hotrawaisaya et al., 2014).

2.4 Guanxi

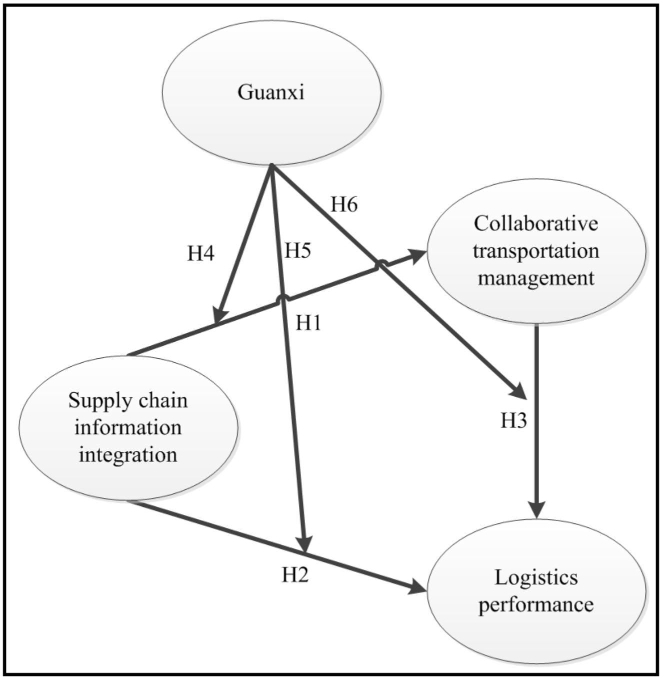
Guanxi is a Chinese term that refers to shared attitudes of two persons towards treating other persons . It is an important element in Chinese culture and social life and is deeply rooted in the minds of Chinese people. Moreover, it has been developed by organisations as a convention of cooperation and exchanging favours with business partners or government authorities (Park and Luo, 2001). Thus, guanxi is treated as a strategic factor in Chinese business practices (Liu et al., 2008; Cheng, 2011; Yen et al., 2016). Guanxi is the concept of exchanging favours and developing relations at the personal or firm level (Luo, 1997; Park and Luo, 2001). In Chinese literature, guanxi is treated as a long-term interpersonal friendship in which individuals are committed to one another on a long-term basis by a hidden bond norm of reciprocity based on equity and exchange of favours (Liu et al., 2008, p. 435). At an organisational level, guanxi refers to a strong link among supply chain partners and, thus, represents an inter-organisational network (Park and Luo, 2001; Lee and Humphreys, 2007). It can also be viewed as social capital that facilitates the creation of value along supply chains (Wang et al., 2021).

The guanxi network can be characterised by its four features: transferability, reciprocity intangibility, and utility (Park and Luo, 2001). Guanxi is viewed as social capital for organisations to achieve superior performance and competitiveness. The development of the guanxi network contributes to the flow of information, access to labour and physical resources, and building an organisation’s image and reputation (Davies et al., 1995). It has also been applied in the field of supply chain management. Lee and Humphreys (2007) found that guanxi is positively related to strategic purchasing, outsourcing, and supplier development. Liu et al. (2008) noted that guanxi moderated the relationship between competence trust and rational risk in marketing channels. Guanxi can be developed through personal visits, exchange of personal favours, mutual communications, jointly participating in social activities, and developing familiarity with each other. Cheng (2011) asserted that guanxi moderated the relationship between relational risk and knowledge sharing in green supply chains. Supply chain members, thus, should enhance their guanxi activities, which, in turn, increases knowledge sharing and information sharing along the supply chains. Wang et al. (2021) also demonstrated that guanxi is a crucial prerequisite for supply chain innovation and enhancing stakeholder value in New Zealand firms.

2.5 Conceptual model and hypotheses

A conceptual model depicting the relationships among SCII, CTM, guanxi, and logistics performance is presented in Figure 1. Based on the review of prior studies, this figure presents the following six hypothesised relationships.

Figure 1 Research framework



Supply chain information integration is the coordination of information sharing, collaborative communication, and supporting technology both within and beyond the organisational boundaries of a supply chain (Leuschner et al., 2013). Information sharing and decision synchronisation have been viewed as crucial enablers of making joint decisions in the orchid flower industry (Hotrawaisaya et al., 2014). In addition, information technology plays both the supporting and enabling roles in collaborative efforts in the supply chain (Esper and Williams, 2003; Buijs and Wortmann, 2014). Thus, supply chain information integration is a crucial driver in facilitating joint decision-making associated with logistics activities, which enhances performance outcomes (Kim and Lee, 2010; Hotrawaisaya et al., 2014; Ralston et al., 2015; Wong et al., 2015; Pradabwong et al., 2017; Lai et al., 2020; Khanuja and Jain, 2020). Wong et al. (2015) pointed out that both internal and external information integration had a positive impact on an organisation's collaborative decision-making in the fields of market research and distribution network design. Lai et al. (2020) found that information integration has a positive impact on collaborative decision-making in the container shipping industry. In uncertain environments, from the perspectives of internal customers and suppliers, the information integration channels enable the shippers and carriers to instantly and accurately share supply chain information for effective implementation of collaborative decisions related to transportation activities. Thus, this study develops the first hypothesis:

H1 SCII has a positive effect on the CTM of manufacturing firms.

Information integration has also been proven to have a positive impact on organisational performance and competitive advantage. Lee et al. (2007) found the integration of internal customers and suppliers to be the most important contributor to the reduction of supply chain cost and increment in supply chain reliability. Yu et al. (2018) pointed out that both integrations of internal and external information are positively related to flexibility, which further improves operational performance. In addition, through collaborative activities, both internal and external information integration can positively improve the logistics service performance (Lai et al., 2020). Yang et al. (2021) found that logistics information integration indirectly influences international distribution centre operators' logistics services and organisational performance. Chang et al. (2021) concluded that the competitive advantage of the international logistics industry was determined by the degree of integration. Hence, close integration of logistics information can help supply chain partners in providing timely, accurate, and high-quality information within departments and beyond organisations to improve logistics performance for greater competitive advantage along the supply chain (Closs and Savitskie, 2003; Bernstein and Hass, 2008; Chang et al., 2021). Hence, we proposed the following hypothesis:

H2 SCII has a positive effect on the logistics performance of manufacturing firms.

The impact of CTM practices on performance has been proven in previous studies. Tyan et al. (2003) found that the adoption of CTM can increase the carriers' asset utilisation rate and reduce the transit time and total costs of related retailers and upstream suppliers. Esper and Williams (2003) found that the CTM could improve carriers' logistics performance in terms of transportation and administration costs, on-time delivery, service levels, visibility, revenue, customer satisfaction, and asset utilisation. Wen (2012), too, found that CTM practices, namely, collaborative planning, information integration, and relationship integration had positive impacts on carriers' customer service, service cost, service quality, and internal operation. Aharonovitz et al. (2018) discovered that transportation and logistics-related collaborations are positively related to logistics performance. Hence, if shippers and carriers adopt CTM practices, they might also be able to achieve performance outcomes, such as, decreasing supply chain costs, shortening transit and delivery cycle time, improving service levels, and mitigating delivery demand variations (Tyan et al., 2003; Chan and Zhang, 2011). By successfully conducting CTM practices, enterprises can further improve their logistics and operational performance (Esper and Williams, 2003; Chan and Zhang, 2011; Wen, 2012; Hotrawaisaya et al., 2014). Thus, this study proposes the following hypothesis:

H3 CTM has a positive effect on the logistics performance of manufacturing firms.

Studies have examined the effect of guanxi on supply chain management and found it to be a crucial determinant of trust, communication, value creation, and commitment in a supply chain (Cheng, 2011; Zhu and Lai, 2019; Geng et al., 2020; Wang et al., 2021). Park and Luo (2001) also pointed out that guanxi is a crucial resource for firms for bridging the gaps in information and resource flows among supply chain partners. Higher guanxi between parties indicates a greater willingness to share information along a supply chain. Moreover, it is assumed to have a moderating effect on SCM (Liu et al., 2008; Cheng, 2011; Ding and Jie, 2020). Firms that have higher guanxi with their partners seek long-term relationships, and, therefore, share logistics information with them based on trust and commitment. When guanxi among manufacturing firms is high, they develop closer integration and cooperation and readily share information. This enables them to better manage their shipping operations by adopting CTM, and, thereby, improve their logistics performance and overall competitiveness in the supply chain. Thus, guanxi plays an important moderating role in information integration, CTM, and logistics performance. Therefore, it is posited that:

H4 Guanxi moderates the relationship between SCII and CTM in manufacturing firms.

H5 Guanxi moderates the relationship between SCII and logistics performance in manufacturing firms.

H6 Guanxi moderates the relationship between CTM and logistics performance in manufacturing firms.

3 Analytical methods

3.1 Questionnaire development

This study used uses a questionnaire survey to collect data from the manufacturing industries in Taiwan. Based on Iacobucci and Churchill's (2010) suggested procedure, a five-part questionnaire was designed for this study. The first part was the demographic information related to both the respondents and their companies. The second part dealt with supply chain information integration. The third part focused on CTM. The fourth part addressed the logistics performance of the responding firms and the fifth part dealt with the seven items pertaining to guanxi.

All questionnaire items were drawn from the review of literature. The SCII construct was adapted from the work of Wong et al.'s (2011) work to compose the items on internal integration, supplier integration, and customer integration. The CTM construct was adapted from the literature (Stank et al., 2001; Feng and Yuan, 2007; Wen, 2012), and had three parts: relationship integration, collaborative planning and forecasting, and IT integration. Five items on logistics performance, namely, speed of delivery, reliability of delivery, flexibility of delivery, responsiveness, and order fill capacity were adapted from prior studies (Rodrigues et al., 2004; Green et al., 2008; Hotrawaisaya et al., 2014). Finally, the guanxi items were adapted from Liu et al. (2008) and Cheng (2011). All items pertaining to SCII, CTM, logistics, and guanxi in our questionnaire were measured on a 5-point Likert scale, where the first point represented 'strongly disagree' and the fifth point – 'strongly agree'.

3.2 Sampling selection

Manufacturing industries in Taiwan were chosen as the source of the sample for this study because they play a vital role as the global source of semiconductors and electronic hardware products (Wong et al., 2020). The Taiwanese manufacturing industry contributed to about 32% of Taiwan's GDP in 2020 (Industrial Development Bureau, 2021). In this study, we examined the values of supply chain CTM in the Taiwanese manufacturing industry. Considering its vital role as a global source of semiconductors and electronic hardware products (Wong et al., 2020), this study examines the values of supply chain CTM in manufacturing industries in Taiwan. Due to time and resource constraints, the sample of manufacturing firms was drawn from the top 1,000 Taiwanese manufacturing corporations listed in the Commonwealth Magazine. To ensure the validity of the questionnaire items, a phone interview with two experts from academia and two managers from the manufacturing industry was conducted. Based on interview feedback, the measurement items were modified. Thereafter, 1000 questionnaires were sent out and the first lot of mailed questionnaires elicited 107 responses. A follow-up mailing was sent two weeks later to the participants who had not responded to the survey and another follow-up mail was sent a month later. These reminders generated 56 more responses. Thus, a total of 163 questionnaires were collected from manufacturing firms. Of these, 11 were incomplete and were excluded from the final sample. This left 152 usable responses, resulting in a response rate of 15.2 percent. However, due to delayed responses, it became necessary to assess the extent of non-response bias in the questionnaire survey. Therefore, the 152 usable responses were divided into the early respondents' group of those who responded without a reminder (first wave) and the late respondents' group of those who responded after the reminders were sent (second wave). The common method, a T-test analysis, suggested by Armstrong and Overton (1977), was performed to assess whether there were significant differences between the two groups' perceptions of various items. The t-test result did not reveal significant differences between the responses from the two groups at the 5% significance level. This indicated congruence between the responses of second-wave and first-wave respondents and the absence of non-response bias.

3.3 Research methods

This study proposed a model to evaluate the value of CTM in Taiwan's manufacturing industry. Since the hypothesised model incorporated more than two endogenous variables as well as latent variables, a two-step SEM approach was adopted to analyse the data and evaluate the hypothesised relationships. Firstly, a confirmatory factor analysis (CFA) was performed to test the validity and reliability of the measurement model. Once these were validated, in the second step, the hypothesised causal relationships in the structural models were assessed. Further, a multi-group invariance analysis was performed in AMOS to assess the moderating effect of guanxi. All analyses were conducted using IBM SPSS and AMOS 20.0 for Windows.

3.4 Characteristics of responses

Table 1 presents the respondents' profile. It includes their job titles, the type of firm for which they worked, years of working experience, and the number of employees in their respective organisations. Regarding the respondents' profiles and characteristics, it is observed that 43.4% were directors, 30.3% were managers, and 18.4% were office clerks. And 57.3% of them had worked in the company for more than 10 years. More importantly, director respondents were actively involved in the shipping and transportation activities of their companies. A large number of respondents being directors or above and with long work experience confirm their abundant practical experience and, thereby, these respondents' eligibility to answer the questions on CTM. This also confirms the reliability of the survey findings.

Table 1 Profile of respondents

Characteristics	*N = 152*	
	Number of respondents	*%*
Job title		
Vice-president or above	8	5.2
Manager/Assistant manager	46	30.3
Director	66	43.4
Clerk	28	18.4
Other	4	2.7
Type of business		
Machinery	20	13.2
Auto parts	18	11.8
Chemical	15	9.9
Computers and peripherals manufacturing	13	8.6
Electronic industries	13	8.6
Semiconductor	9	5.9
Garments and textile	8	5.3
Optoelectronic and optical	8	5.3
Metal	8	5.3
Plastic and rubber industries	5	3.3
Other	35	23.0
The years of company's existence[a]		
Less than 5 years	0	0
6~10 years	3	2.0
11~15 years	10	6.8
16~20 years	21	14.2
More than 21 years	114	77.0
Years of respondents' working experience[b]		
Less than 5 years	34	22.7
6~10 years	30	20.0
11~15 years	28	18.7
16~20 years	27	18.0
More than 21 years	31	20.6

Notes: a represents four respondents who did not provide this information; b represents two respondents who did not provide this information; c One U.S. dollar equals approximately 29.0 New Taiwanese (NT) dollars; d represents two respondents who did not provide this information.

Table 1 Profile of respondents (continued)

Characteristics	*N = 152*	
	Number of respondents	*%*
Number of company's employees for company		
Less than 100	19	12.5
101~500	65	42.8
501~1,000	23	15.1
1,001~2,000	18	11.8
More than 2,001	27	17.8
Annual revenue of company (Billion NT$[c])[d]		
Less than $ 1.0	34	22.7
$ 1.1 ~ 5.0	55	36.7
$ 5.1 ~ 10.0	21	14.0
$ 10.1~ 50.0	35	23.3
More than $ 50.0	5	3.3

Notes: a represents four respondents who did not provide this information; b represents two respondents who did not provide this information; c One U.S. dollar equals approximately 29.0 New Taiwanese (NT) dollars; d represents two respondents who did not provide this information.

The respondents' firms were manufacturers of machinery (13.2%), auto parts (11.8%), chemicals (9.9%), computers and peripheral (8.6%), and electronics (8.6%). The responding firms from the semiconductors, garments and textile, optoelectronics and optical, metals, and plastics and rubber industries made up less than 6% of the total. The results also show that approximately 77% of the firms had been in existence for 21 years or more, 14.2% for approximately 16 to 20 years, 6.8% for approximately 11 to 15 years, and 2% had been in operation for less than 10 years.

The respondents were also asked to provide information on the number of employees and the organisation's annual revenue. Results showed that 42.8% of the firms had between 101 and 500 employees, 27% had between 501 and 2,000 employees, 17.8% had more than 2001 employees, and 12.5% had 100 or fewer employees. As for annual revenue, the majority of the responding companies, (36.7%) had annual revenue of between NT$ 1.1 and 5.0 billion, 22.7% reported revenue less than NT$ 1 billion, while 40.6% of the respondents reported annual revenue of NT$ 5.1 billion or more.

4 Data analysis and results

4.1 Descriptive statistical analysis and reliability tests

Table 2 summarises the respondents' perceptions on the various dimensions of SCII, CTM, logistics performance, and guanxi. Results show that internal integration (mean = 4.075) was perceived as that the most important dimension of SCII, followed by customer integration (mean = 3.852) and supplier integration (mean = 3.572). With respect to the CTM, relationship integration (mean = 3.840) was perceived as the most important dimension, followed by IT integration (mean = 3.610) and collaborative planning and forecasting (mean = 3.589). The overall logistics performance as perceived by respondents had a mean value of 4.097. Responsiveness was rated as very satisfactory (mean = 4.243 on a five-point scale). On the other hand, the mean value of the guanxi dimension 3.544 was considered to be fair and satisfactory on a five-point scale. Specifically, 'maintaining long-term relationship with transportation operators is important to our company' received the respondents' highest mean rating (4.138). On the other hand, the item that received the lowest rating of 3.033 on a five-point scale was 'our leaders and the leaders of our partners always invite each other to participate in social activities'.

Table 2 Descriptive statistics and reliability test

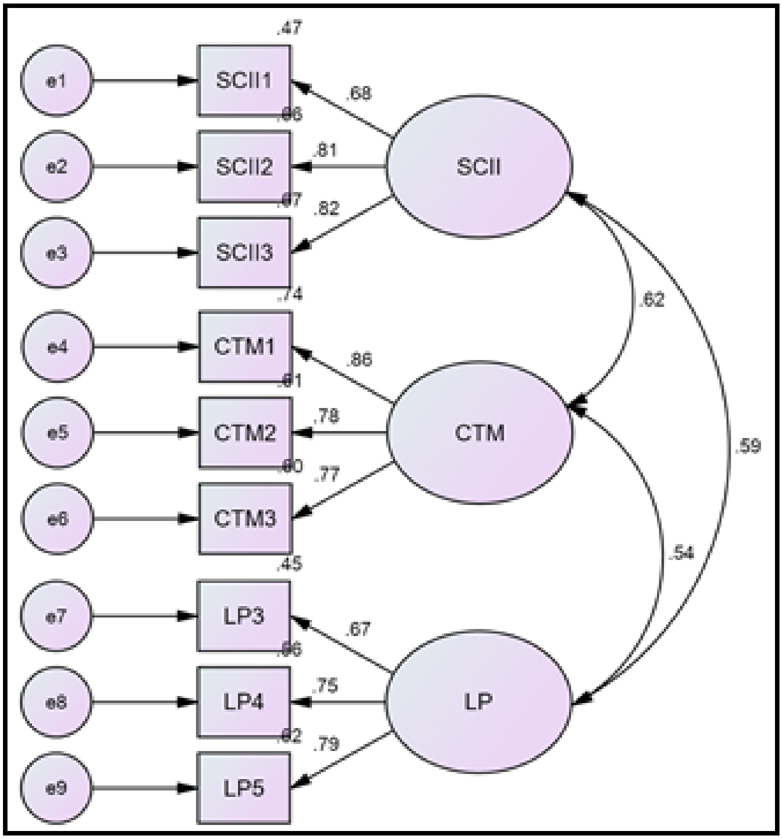
Dimensions	*No. of items*	*Mean*	*S.D.*	*Cronbach Alpha*	*Range of corrected item-total correlation*
Internal integration	5	4.075	0.703	0.875	0.658–0.755
Supplier integration	5	3.572	0.812	0.896	0.599–0.856
Customer integration	5	3.852	0.753	0.894	0.646–0.797
Relationship integration	6	3.840	0.731	0.897	0.577–0.785
Collaborative planning and forecasting	7	3.589	0.849	0.911	0.533–0.858
IT integration	4	3.610	0.792	0.900	0.717–0.849
Logistics performance	5	4.097	0.692	0.795	0.518–0.628
Guanxi	5	3.544	0.823	0.837	0.402–0.723

To determine whether the aforementioned dimensions were consistent and reliable, both Cronbach's alpha coefficients and the corrected item total correlation (CITC) were used. The Cronbach's alpha values of all dimensions were well above 0.75, which is considered adequate for confirming a satisfactory level of reliability level in this research (Iacobucci and Churchill, 2010; Hair et al., 2010). In addition, Table 2 presents the CITC range for each dimension, indicating that all scores are well above the suggested threshold of 0.4. Hence, the results confirm that each item measured the respective underlying construct (Iacobucci and Churchill, 2010).

4.2 Validity of the measurement model

Further, to assess the unidimensionality, convergent validity, and discriminant validity of the construct, a confirmatory factor analysis (CFA) was performed. The initial estimated model was treated as discredited because the $\chi 2$ value ($\chi 2(41) = 97.533$, $p = 0.000$) was statistically significant at 0.05. Therefore, it was necessary to revise the model by inspecting the standardised residuals matrix and modification indices. The inspection showed that the residual value of one pair (LP1 and LP2) was found to be as high as 1.755, and the modification indices of the pair exceeded 4.0. Therefore, as suggested by Hair et al. (2010), the model was revised by deleting the variables LP1 and LP2. The revised model (Figure 2) provided an adequate model fit ($\chi 2/df = 2.366$, GFI = 0.927, CFI = 0.945, and RMR = 0.022), implying that the modified estimated model was acceptable (Hu and Bentler, 1999; Hair et al., 2010). The subsequent unidimensionality, convergent validity, and discriminant validity of the modified model are discussed in Figure 2.

Figure 2 Confirmation factor analysis



Notes: SCII: supply chain information integration, CTM: CTM, LP: logistics performance.

In Table 3, the incremental fit indices, such as TLI and CFI values, are higher than 0.90. Moreover, absolute fit indices with RMR and RMSEA values are below 0.08. These values suggest that the constructs are all unidimensional (Anderson and Gerbing, 1988). Hair et al. (2010) have suggested that critical ratio (CR) values, item reliability (R^2), and average variance extracted (AVE) can be applied to test convergent validity. As shown in Table 3, all the factor loadings were found to be greater than 0.6. These significant CR values for factor loadings prove that the measured variables represent the underlying constructs. In addition, it was expected that the R^2 and AVE values must exceed the cut-off values of 0.4 and 0.5, respectively (Fornell and Larcker, 1981; Hair et al., 2010). Table 3 shows that the aforementioned indices met the recommended thresholds. Thus, both R^2 and AVE values indicate that all the indicators measure the same construct and provide satisfactory evidence for convergent validity (Anderson and Gerbing, 1988; Hair et al., 2010).

A rigorous method to test discriminant validity is to compare the AVE value with the squared correlation between constructs. Table 4 shows that the highest squared correlation occurred between SCII and CTM at 0.260, which was, apparently, lower than the respective AVE of SCII and CTM their respective AVEs. Thus, the results confirm the discriminant validity of the constructs. In addition, the composite reliability coefficient was used to assess whether the specified indicators sufficiently measured the related constructs (Churchill, 1979). Higher composite reliability values indicated the high reliability of the constructs. This indicated highly reliable constructs which showed that the indicators were highly inter-correlated, indicating that all of them measured the same latent construct. Table 4 shows that all constructs exceeded the cut-off value of 0.7 suggested by Bagozzi and Yi (1988).

Table 3 Results of CFA analysis

Latent variables	*Factors*	*Standardised factor loading*	*S.D.*	*Critical ratio*	R^2	*AVE*
ξ^1 SCII	Internal integration	0.683	0.085	8.307	0.467	0.599
	Supplier integration	0.811	---[a]	---	0.658	
	Customer integration	0.820	0.100	9.384	0.672	
η^1 CTM	CTM1	0.859	0.085	9.848	0.738	0.650
	CTM2	0.784	---	---	0.614	
	CTM3	0.773	0.092	9.611	0.697	
η^2 LP	LP3	0.667	0.110	7.014	0.445	0.541
	LP4	0.748	0.121	8.003	0.559	
	LP5	0.787	---	---	0.619	

Notes: [a]Indicates a parameter fixed at 1.0 in the original solution; fit index: $\chi^2 = 56.787$, df = 24, $\chi^2/df = 2.366$, RMR = 0.022, RMSEA = 0.070, GFI = 0.927, CFI = 0.945, IFI = 0.946, TLI = 0.917.

Table 4 Discriminant validity and composite reliability

Constructs		*Composite reliability*	ξ^1 *SCII*	η^1 *CTM*	η^2 *LP*
ξ^1	SCII	0.817	0.599[a]		
η^1	CTM	0.848	0.260[b]	0.650	
η^2	LP	0.779	0.215	0.171	0.541

Note: [a]AVE value is on the diagonal, [b]squared correlation.

4.3 Research hypotheses testing

Once the measurement model was proved to be acceptable by testing its validity and reliability, the hypothesised relationships were tested using maximum likelihood estimations. Results indicated that the estimated model had a good model fit, with the indices of GFI = 0.927, CFI = 0.945, IFI = 0.946, and TLI = 0.917. Each of these exceeded the cut-off value of 0.9 (Hair et al., 2010). Moreover, both measures of absolute fit indices, namely, the RMR (value = 0.022) and RMSEA (value = 0.070) were below the recommended cut-off value of 0.08. The normed chi-square (χ^2/df) also was within the recommended threshold range with a value of 2.366.

The results of hypothesis testing are summarised in Table 5. The hypotheses were found to be significant, and the results met the expectations. SCII was found to have a positive relationship with CTM ($\beta = 0.681$, $p < 0.01$) and logistics performance ($\beta = 0.373$, $p < 0.01$). This finding supported H1 and H2. CTM was also found to have a positive impact on logistics performance ($\beta = 0.222$, $p < 0.01$) and supporting H3.

Table 5 Results of structural equation modelling

Relationships		*Unstd. estimate*	*S.E.[a]*	*CR[b]*	*P*	*Supported*
H_1	SCII→CTM	0.681	0.110	6.210	0.000***	Yes
H_2	SCII→LP	0.373	0.118	3.161	0.002***	Yes
H_3	CTM→LP	0.222	0.103	2.150	0.032**	Yes

Notes: [a] SE is an estimate of the standard error of covariance, [b] CR is the critical ratio obtained by dividing the covariance estimate by its standard error, ***p < 0.01; **p < 0.05, Fit indices: $\chi^2 = 56.787$ (p = 0.000), df = 24, $\chi^2/df = 2.366$, GFI = 0.927, CFI = 0.945, IFI = 0.946, TLI = 0.917, RMR = 0.022, RMSEA = 0.070.

4.4 Further analysis: moderating effect

To further determine whether guanxi plays an important moderating role in CTM practices (H4–H6), a multi-group invariance analysis in AMOS, commonly suggested by researchers, was performed steps suggested in prior studies (Wong et al., 2011; Yang and Chao, 2017) were followed. The mean value of seven guanxi-related items was used as the mean split to categorise respondents into two groups-one with high guanxi (n=85) and the other with low guanxi (n = 67). The first step was to compare the baseline model and structural weight model. Table 6 shows that the χ^2chi-square difference values were significant between these two models ($\Delta\chi^2 = 13.320$, $\Delta df = 3$, p = 0.004), reflecting that the parameter values are different between the low and high guanxi groups. Therefore, a partial invariance analysis was performed to assess the equality of hypothesised paths between the low and high guanxi groups. From Table 6 it may be observed that only the effect of SCII on CTM shows different outcomes for these two groups at the 0.05% level ($\Delta df = 12.466$, p = 0.002). This supports H4. Specifically, the impact of SCII on CTM for high guanxi group ($\beta = 0.709$, $p<0.000$) is greater than its impact on low guanxi group ($\beta = 0.512$, $p < 0.000$). This finding suggests that manufacturing firms may enhance their internal-, supplier-, and customer- linkages by sharing information, which, in turn, could increase their supply chain CTM activities in terms of joint transportation planning, recommending modes of transport, sharing information on vehicle needs, sharing destination information, and forecasting cargo space. However, this study does not find any moderating guanxi effect on the relationship between SCII and LP, or between CTM and LP. The reason could be that that the majority of responding firms were traditional manufacturing firms (approximately 72%). Unlike high-tech firms, the traditional manufacturing firms pay little attention to building guanxi networks with their supply chain partners when adopting CTM activities.

Table 6 Multi-group invariance tests between baseline model and constrained model

Model estimated	χ^2 *(df)*	χ^2/df	*GFI*	*CFI*	*RMR*	$\Delta\chi^2$ *(Δdf)*	*P value*	*Low Guanxi*	*High Guanxi*	*Hypotheses*
Baseline model	112.661 (48)	2.347	0.872	0.879	0.029					
Constrained model	125.981 (51)	2.470	0.862	0.860	0.050	13.320 (3)	0.004**			
Constrained path										
SCII→CTM	125.126 (49)	2.554	0.862	0.879	0.049	12.465 (1)	0.000**	0.525**	0.709**	H4 supported
SCII→LP	114.575 (49)	2.338	0.873	0.878	0.031	1.914 (1)	0.166	0.404**	0.430**	H5 not supported
CTM→LP	113.086 (49)	2.308	0.873	0.880	0.030	0.425 (1)	0.514	0.065	0.084	H6 not supported

Note: t-values are in brackets; $^{**}p < 0.05$; $^{*}p < 0.1$.

5 Discussion of results and conclusions

This study aimed to empirically evaluate the CTM practised by Taiwan's manufacturing firms, by using guanxi as a moderating variable. The following are the results derived from the analysis.

From the respondents' perceptive, Taiwanese manufacturing firms perform well in integrating internal information. Of the CTM practices, relationship integration was perceived by respondents as the most widely implemented practice. The results also reveal that manufacturing firms have good logistics performance in terms of responsiveness. However, the results indicate that manufacturing firms did not actively engage in building guanxi with their supply chain partners (mean=3.544). Specifically, the guanxi-related survey item with which most respondents agreed was 'maintaining long-term relationship with transportation operators is important to our company', while the guanxi-related survey item with which the respondents disagreed most was 'our leaders and the leaders of our partner always invite each other to participate in social activities'.

The SEM results show that, in Taiwan's manufacturing firms, SCII is positively associated with CTM (H1) and logistics performance (H2). Thus, a high level of information integration among business units, suppliers, and customers can facilitate the implementation of the CTM. Moreover, a high level of SCII can significantly improve manufacturing firms' logistics performance in terms of responsiveness, delivery flexibility, and order fill capacity. This finding is consistent with those of previous studies by Kim (2006), Cao and Zhang (2011), and Tyan et al. (2013).

The findings also show that CTM is significantly related to logistics performance in manufacturing firms (H3). Thus, CTM because it necessitates relationship integration, collaborative planning and forecasting, and IT integration, can help manufacturing firms in improving their logistics performance. This finding is consistent with the finding of Stank et al. (2001), Ruamsook et al. (2009), and Cao and Zhang (2011).

Finally, guanxi is found to moderate the relationship between SCII and CTM of manufacturing firms (H4). This is consistent with the findings of Liu et al. (2008). SCII is positively associated with CTM in the high-guanxi group. Therefore, manufacturing firms should engage in supply chain linkages, namely, internal, supplier linkages, and customer linkages. However, the majority of responding firms (about 72%) were traditional manufacturing firms that might be paying little attention to building their guanxi network while engaging in CTM activities, which may have led to tilting the overall balance of response of the participants in favour of not finding a moderating effect of guanxi on the relationships between SCII and LP and between CTM and LP.

The above findings suggest several practical and managerial actions that manufacturing firms might take. First, this study demonstrated that a higher level of SCII can provide accurate and timely information for CTM implementation and improve logistics performance. Therefore, an effective information system or platform should be built to facilitate coordination and information sharing along supply chains. For this purpose, manufacturing firms should enhance their internal communication capability to be able to form effective links for sharing logistics information with supply chain partners using information technology. By these actions, manufacturing firms would involve business units and their suppliers and customers in collaborative logistics activities and joint decision-making (Hotrawaisaya et al., 2014).

Second, CTM is positively related to logistics performance. Thus, by adopting CTM practices in their logistics activities, manufacturing firms may significantly enhance their logistics performance in terms of customer responsiveness, the flexibility of delivery, and order fill capacity. Manufacturing firms can collaborate in logistics activities, such as joint transportation planning, recommending modes of transport, sharing information on vehicle needs, sharing destination information, forecasting cargo space, and so on. In particular, high-tech firms are sensitive to the delivery time and have high unit transportation costs. Therefore, it is suggested that high-tech firms should adopt CTM practices with their supply chain partners. It is also important to note that SCII is a crucial antecedent to adopting CTM practices within a supply chain.

Finally, this study suggests that SCII could significantly increase the logistics performance of firms with high guanxi and their supply chain partners. Thus, manufacturing firms should engage in activities for building guanxi, a feature of the Chinese culture, activities with their partners and motivate them to integrate logistics information and adopt CTM practices. It is evident that high guanxi with their partners helps manufacturing firms to significantly enhance their logistics performance through information integration and CTM practices. Therefore, managers desirous of expanding their business operations in regions where Chinese culture prevails, should build a guanxi network in the supply chain by communicating frequently with their partners, visit them and exchange personal favours, and invite them to annual dinners and other social events (Wang et al., 2021).

However, that this study has several limitations that future research should avoid. First, this study focuses on how manufacturing firms build their guanxi network with supply chain partners when adopting CTM practices to improve logistics performance. Compared to traditional manufacturing firms, high-tech firms that are time-sensitive and incur high transportation costs are likely to pay more attention to CTM activities. This suggests evaluation of the impact of CTM on logistics and organisational performance in high-tech firms or e-commerce businesses as an area for future research. Second, this study was limited to evaluating guanxi and CTM specifically in Taiwan. Since the booming development of cross-border e-commerce has increased the demand for inland transportation, future research can generalise this CTM model to other regions that practice Chinese culture, such as mainland China and the ASEAN community. Finally, the data for this study were collected at a particular point in time. Therefore, future research should use longitudinal studies to investigate the effect of SCII and CTM on organisational performance.

Acknowledgements

The authors greatly appreciate Mr. M.H. Yueh for his assistance in data collection and two anonymous reviewers for their very helpful comments on this paper. This research was supported by the 4th Educational Training Program for the Shipping, Port and Logistics from the Ministry of Oceans and Fisheries, Korea.

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