Supply chain collaboration and performance: an empirical study of maturity model

Thi Ho¹ · Arun Kumar¹ · Nirajan Shiwakoti¹

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Abstract

Supply chain collaboration (SCC) is a competitive tool used to improve the business performance of an organisation and the entire supply chain. Firms have therefore strived to achieve a greater collaboration level; however, most of the collaboration initiatives end up in failures. It is confirmed that how SCC impacts performance and how it leads to higher levels of performance are not well understood in real world. Especially, there is a dearth of empirical research on the analysis of the specific industry to minimize the chance of failure of implementation phase. Given these limitations, this paper aims to explore in-depth the relationship of SCC mechanisms; maturity level in particular; and performance outcomes in a specific industry. A maturity model for SCC based on capability maturity model integration approach is used to evaluate the current practices as well as to measure the maturity level of SCC of textile and garment case studies. In order to analyse how different maturity levels impact the performance, actual data on performance indicators was collected. The findings show the applicability and usefulness of the model. The relationship between SCC mechanisms and performance is confirmed with the role of internal collaboration as mediators. The in-depth exploration has also indicated that internal collaboration, including information integration and operations management, moderates the relationship between external integration and performance.

Keywords Supply chain collaboration · Maturity model · Performance · Operations management · Information integration

1 Introduction

In the 1980s and 1990s, Wal-Mart and Proctor & Gamble inspired companies with their successful story of reducing cost by joining in trading relations that consider exchanging information as the key component [1]. Since then, collaboration in the context of supply chain management has been promoted strongly by both scholars and practitioners [2]. Today, collaboration is one of the most talked about topics in the business world [3] and has become a major challenge for managers in industrial companies [4].

Collaboration in the supply chain is considered as a competitive tool used to improve the business

performance [3]; and scholars have affirmed a strong link between SCC and performance levels [5]. Therefore, achieving a greater collaboration level to achieve better performance outcomes is the ultimate goal of all firms [6]. In fact, many attempts have fallen short of the participants' expectations and have ended in failure [2]. One survey revealed that only 35% of collaboration initiatives are even moderately successful [7]. The success rate of collaboration initiatives has been less than expected [8, 9].

Yet our knowledge is relatively weak about the connections between collaboration, resulting performance and how it leads to the greatest overall performance improvements [10]. How exactly different maturity levels of

✉ Thi Ho, phuongdung2512@gmail.com; Arun Kumar, a.kumar@rmit.edu.au; Nirajan Shiwakoti, nirajan.shiwakoti@rmit.edu.au | ¹School of Engineering, RMIT University, Melbourne, Australia.

collaboration lead to different levels of performance is not well understood and has not been adequately addressed in literature [5, 11]. This kind of link is mentioned to be still in its early stage [12] with a lack of evidence of extensive implementation [13]. The literature is still searching for the relationship between maturity level and performance in a supply chain context [14, 15]. Furthermore, it is highlighted that the relationship between collaboration and performance was examined mainly on a quantitative basis with the majority of papers to test the hypothesis [16]. There are calls for further empirical research on this link [17]. Especially, there is a need for qualitative based research such as in-depth case studies to increase our understanding of SCC and performance in the real-world [16]. Furthermore, since the relationship between SCC and performance is mentioned to be almost universally accepted without much proof with a few papers based on primary data and empirical studies [16].

As regards to the industry type, since it is affirmed as a control variable correlated with supply chain performance and practices [18], more insights for best practices of industry-specific bias would be very beneficial to minimize the chance of failure of implementation phase [6]. Cao and Zhang [6] mentions this lack in the current body of knowledge. In-depth research in specific industry will help industrial managers to have the strategic decisions of key actions to perform for their organizations.

Given these limitations, this study aims at developing a more in-depth research at exploring the relationship between collaboration maturity levels and performance in a specific industry. Through a maturity model for SCC (MM-SCC) which have been developed in previous study, SCC practices are evaluated, and the current maturity level is measured. The effects on the performance are quantitatively and qualitatively measured with actual data of key performance indicators (KPIs) and subjective evaluation of managers to reconfirm and explain more for the effects. This also fills the gap of quantitative-based research measuring the effects with real data in the existing body of knowledge [16]. Case studies are chosen to address the research aim.

The selected context is textile and apparel industry with the following reasons. Among industry types, the textile–apparel industry is recognized as one of the longest, most fragmented and inflexible supply chains in the world [19, 20]. With characteristics of short product life cycle, high demand uncertainty and high volatility [14, 15, 21] it is necessary for textile–apparel industry to have a responsive and efficient supply chain [20, 22]. This responsiveness and efficiency characteristic are affirmed to be affected by the effectiveness in communicating [23] and by the level of collaboration among partners in the chain

[24]. This selection is due to the significance of high collaboration level to the success of the chain [20, 22].

Since the textiles and clothing industry is mentioned to be a major part of manufacturing and trade as well as the gate of choice to step into industrialization in most developing countries [25]. A developing country is chosen as a case study in this research. Among the leading countries in this industry, Vietnam is recognized as one of the countries with lowest added value in the apparel value chain [26]. Moreover, Vietnamese chain has witnessed a decreasing trend in value added in manufacturing during recent years with high unit cost [27]. The implications of this research can be common factors for the development of the textile and apparel sector in scores of Vietnam specifically and of developing countries in general. Having a clear picture of MM-SCC and textile–apparel context is helpful in improving the awareness of contributions of this study to the body of knowledge.

The research is structured as follows. The second section provides a theoretical background for SCC, the maturity model, and MM-SCC. This is followed by the methodology adopted for this research and a description of data collection. The fourth section presents the results. The next section illustrates the discussion and managerial implications. There ends with contribution and future research.

2 Theoretical background and model development

This study is conducted based on applying proposed model MM-SCC in a particular industry. This section presents a review of the literature pertinent to the aim of developing the model. The literature review has been sorted according to three distinct categories. The first category broadly outlines the concepts of SCC and the second category highlights the maturity model. The latter category illustrates the developed model in SCC field.

2.1 Supply chain collaboration

SCC is defined as the inter-organisational processes among and between members of a supply chain [2, 6, 28–31], which aims to create a seamless and synchronised supply chain that leads to increased responsiveness and performance to satisfy customers [28, 30]. These activities are based on mutual goals and trust, along with shared risk and reward [2, 6, 8, 29, 31].

Researchers use the word “collaboration” to express the context of their research loosely [31]. In the context of supply chain, collaboration is complemented by other terms such as “integration” [3, 32], “cooperation” [33] or “coordination” [34]. Some authors refer collaboration as

inter-firm cooperation, integration or coordination and often use them interchangeably based on the main goal to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer [35]. However, in some research, collaboration includes a spectrum of relationship types. These different relationships in supply chain follow movement paths, such as Open market negotiations–Cooperation–Coordination–Collaboration [36]; Communicator–Coordinators–Cooperators–Collaborators [28] or Communication–Coordination–Intensive collaboration–Partnerships [7]. There is no consistency of the definition as well as the position of collaboration, integration, coordination and cooperation in a supply chain among scholars. As such, in this study, the researchers consider these terms as the phenomenon of inter-organisational processes among and between members of a supply chain based on mutual goals, mutual trust, shared risk and shared reward rather than the definition of “closeness” or “together” level in one relationship.

2.2 Maturity model

The word “maturity” is used here to denote the quality concept developed by Crosby [37]. The earliest model of Quality Management Maturity Grid evaluated the status and evolution of a firm to quality management [37, 38].

Maturity model is defined as a matrix of practices which is considered as a development path or an improvement tool for organizations [39]. Maturity models have been adopted in many management research fields, including process management and performance management [5] with a variety of application domains, including supply chain management and collaboration process [40].

Maturity model is simply referred to capability maturity model (CMM)/capability maturity model integration (CMMI) by many investigators [39]. CMMI is a process maturity framework with a set of key processes [41] guiding organizations toward a more disciplined and higher maturity level [42]. Table 1 summarises the CMMI model according to the characteristics of each maturity level [43].

To reach a particular level, an organization must satisfy all of the goals of the process area or set of process areas that are targeted for that level.

Evidence has shown that maturity models are applied in a variety of domains, however, maturity models for processes in the field of supply chain and collaboration is currently not well-understood [5, 40]. Given this limitation, the authors have developed a maturity model for supply chain collaboration (MM-SCC) based on CMMI approach [15]. This model is considered as a guidance for organisations in implementing SCC processes sequentially through stages. This is also a diagnostic tool for organisations to evaluate the current practices and to improve to a higher level.

2.3 MM-SCC

As mentioned in the definition, SCC is a set of process requirements. To build the model, a literature review on these processes has been done by the authors, including prerequisite processes as antecedents; key activities; and sustaining and improvement activities [44]. The model was further developed from our previous work, based on CMMI approach.

The summary of model is provided in Table 2, including two main parts: maturity levels and process requirements.

Each process involves the activities (sub-process). These sub-processes will give a detailed instruction for implementing the main processes. More details of sub-processes of each process requirement are illustrated in “Appendix 1”.

This study is the very first application of this model in real environment to explore in-depth the SCC phenomenon.

3 Methodology

The section presents the strategy to address the research problems with the constitution of the research methods for data collection and analysis. This is a mixed-method

Table 1 CMMI model. Source: [43]

Maturity level	Characteristics
1. Initial	Processes are ad-hoc and chaotic
2. Managed	Processes are planned, performed, measured, and controlled according to documented plans
3. Defined	Processes are well characterized and understood, and are described in standards, procedures, tools, and methods
4. Quantitatively managed	Processes are controlled using statistical and quantitative techniques
5. Optimising	Processes are continually improved based on a quantitative understanding of the common causes of variation inherent in processes

Table 2 MM-SCC model. Source: [15]

Level	Characteristics	Collaboration process requirement
1. Initial	Collaborative supply chain processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment for processes to perform. Success in collaboration process may happen, but it is still dependent on individual initiative and skills, not on the use of proven processes, and organizations are not able to repeat their past successes	N/A
2. Managed	SCC in organizations starts to be modified towards basic activities. Collaboration processes are planned with requirements and involved activities. Commitments are established among relevant stakeholders. Collaboration processes are performed and controlled to meet requirements according to documented plans but mostly reactive and repeatable	Antecedents 1. Managerial commitment and strategic intent 2. Resource investment and development 3. Free information flow and system integration 4. Relationship building and management 5. Formalisation 6. Rationalisation
3. Defined	SCC processes are well characterized, understood and described through a greater attention to documentation, standardization, procedures, tools, and methods. Standard collaboration processes are managed proactively and consistently spread to different areas of the organization. Process objectives are established and ensured to appropriately address	Key activities 1. Information sharing 2. Goal congruence 3. Decision synchronisation 4. Incentive alignment 5. Resource sharing 6. Collaborative communication 7. Joint knowledge creation
4. Quantitatively managed	Collaboration processes are quantitatively managed in accordance with agreed-upon metrics. Detailed measures of supply chain performance are collected and statistically analyzed. Special causes of collaboration process variation are identified and corrected to prevent future occurrences. Collaboration process happens at a strategic level where integrated and coordinated strategies aim at achieving the overall supply chain performance between multiple parties	Sustaining and improvement activities 1. Performance measurement
5. Optimising	Common causes of process variation are addressed, identified, evaluated, and deployed. Collaboration process performance is continually improved through both incremental and innovative technological improvement towards the common objectives of supply chain. The interaction is truly through all chain organizations and collaboration happens to achieve the maximum supply chain effectiveness	Sustaining and improvement activities 1. Continuous improvement

study including two phases: model content validity and case studies. The subsequent sections are the results expanding upon this research design.

3.1 Phase 1: model content validity

In this study, the model is validated before its application. The content validity check is based not only on the information available in the relevant literature, but is also checked in consultation with a panel of practitioners and academic experts with substantial knowledge about the topic and the context [2, 45–47]. Semi-interview method with questionnaire tool is used to ask for the experts' agreement level on the model. The result is quantitatively analyzed through content validity ratio (CVR) to decide the appropriateness of model's content [45].

3.1.1 Expert selection

In the supply chain field, title of experts who participated in the survey relating to SCC aspect is shown in Table 3.

Table 3 Expert positions

Experts	Positions
Practitioners	Executive positions: CEO/President/Vice president/Director [3, 6, 48] Manager/executive/senior staff in: Supply chain/logistics [3, 30, 45, 49–51] Sales [45, 49] Purchasing [30, 45, 49] IT [50] Manufacturing/production [49, 50]
Academics	Professor/Lecturer [2]

3.1.2 Method and tool

A semi-structured interview with questionnaire which incorporated the MM-SCC model is used to ask for the experts' agreement with regards the model. Two kinds of questions were used, close-ended and open-ended questions.

- For close-ended questions, a five-point Likert scale is used to allow respondents to indicate the extent to which they agreed or disagreed with the model. For open-ended questions, the respondents are asked to give their opinions on the model. If a process of item needed to be added, the survey will be conducted again.
- For close-ended questions, data are statistically analysed to confirm the validity of measurement using the content validity ratio (CVR) as a content validity index in rejection or retention of specific items [52]. CVR is calculated for each level, process requirement and sub-process requirements. CVR is a direct linear transformation from the percentage saying "agree and strongly agree". This ratio has to meet the minimum required CVR to be not eliminated [52].

$$CVR = \frac{n_{e-N/2}}{N/2}$$

n_e = number of experts indicating agree and strongly agree, N = total number of experts.

3.2 Phase 2: case study

The model is then applied in case studies to evaluate the current practices and measure the SCC level. These outcomes of practices and levels are used along with performance outcomes to evaluate and analyze the relationship between SCC and performance. The effects of SCC on performance are quantitatively assessed through real data of KPIs and subjectively evaluated by managers as well.

3.2.1 Number of cases

As this is the first application of the model, the selection of multiple cases is needed to assure the robustness of the model by replicating the finding. In addition, due to the benchmark function of the model, multiple-case design can provide the comparisons of how SCC affects performance among the contexts. In this study, two cases varying in scale and culture are chosen due to following reasons. Since the function of the model is to diagnose the current practices and problems to make the improvements, the application of the model requires an in-depth

research with many activities involving different functions, departments and respondents. Multiple sources of evidence need to be collected to ensure both the reliability and construct validity for the evaluation. As such, it is not a small case study at each case. In addition, relationships in a supply chain is mentioned to be varying from tier to tier [53]; in one organization under the same maturity level, the relationship with different partners may vary from partner to partner. Multiple unit of analysis in one case is chosen to explore the phenomenon in-depth.

The embedded, multiple-case (multiple contexts, multiple units of analysis) type with two cases is suitable for the research purpose by covering the multiple-case design and providing sufficient resources for in-depth research at each case.

3.2.2 Model application

To assess the current maturity levels, the respondents answer whether or not the organisation performs and meets the process requirements in the MM-SCC model. If the answer was "yes", evidence had to be provided to support the affirmative answer. Data collection for this study utilizes multiple sources of evidence, including on-site interviews, observations and documentary. While the on-site interviews and observations are qualitative in nature, documentary evidence was collected for each answer "yes". If one answer was negative, this meant this maturity level was not met [54]. The enterprise will receive the classification of the last maturity level completed. From this maturity classification, the enterprise will establish improvement plan to achieve the target. This classification allows the enterprise to define an improvement roadmap.

3.2.3 Case information

Two garment companies were chosen. Real names were redacted for privacy purpose. This research has obtained the Ethics approval from College Human Ethics Advisory Network (CHEAN), College of Science, Engineering and Health, RMIT University (ID: SEHAPP 61-16) to conduct the interviews and collect data at two textile apparel companies in Vietnam (including consent form of invitation to participate in the research project and approval letters from two companies).

In the Vietnam context, customers appoint the suppliers for the manufacturers; as such this industry tends to be dominated by customer relationship. This research focuses on the evaluation of the downstream relationship between garment manufacturers and customers.

Summary of case information is presented in Table 4.

Table 4 Case information

	ABC company	XYZ company
Type	Joint Stock Company 100% of capital from Vietnam Over 40 years	Limited Liability Company 100% of capital from a Hong Kong group Over 10 years
Position	One of the leaders in the Vietnamese garment industry	One of the ten largest export garment businesses
Revenue	An export sale: US\$651 million (2015)	Revenue: US\$720 million (2015)
Product	Suits, shirts, trousers	Sweaters and T-shirts
Customer	International customer: more than 50 international brands Domestic customer: Under its own house brand's designs	Mainly 8 famous international brands from US and Japan
Production modality	Cut-Make-Trim (CMT)—main customers ^a Free-On-Board (FOB) ^b Original-Brand-Manufacturing (OBM) ^c	FOB

^aMaterials are provided by customers. Enterprises simply perform the manufacturing and assembling function

^bEnterprises offers customers their own materials or outsource materials from the nominated suppliers

^cProducts are designed, manufactured, and retailed under own house brands

3.2.4 KPI selections

Following that step, the authors then explore how different maturity levels affect performance outcomes. Due to the nature of the CMT and FOB method, Vietnam's apparel enterprises only perform outsourcing contracts and the customers provide firms with all design as well as transportation arrangements [55]. Therefore, upgrading quality and on-time delivery become more transparent in cultivating importers' confidence in Vietnamese products [55]. The literature also indicates that quality and delivery schedule are common concerns for both customers and manufacturers [56]. Additionally, because CMT is the simplest production practice—only requiring manufacturing capacity and a little designing capacity for making counter-samples—Vietnamese manufacturers target their efforts at strengthening their operational capacity [55]. Therefore, capacity utilisation (the ratio of the actual output over the target output) is also considered in this study. Overall, data related to quality level, on-time delivery and capacity utilisation are collected to assess the efficiency of the system.

4 Results

This section presents the findings of the model application which is the expansion of the work of research design at Sect. 3. Starting with the results of content validity, the latter part of this section is the results of model application including measured SCC maturity level at each case, and performance outcomes with the results of KPIs. This section establishes the setting that forms the basis of the analysis in the subsequent Sect. 5.

4.1 Model content validity

The pilot was done to identify format, ambiguous items, the quality of worded questions and instructions for the model. Pretesting and piloting is conducted. Following piloting, the final version of the questionnaire is prepared to go on to be tested for the content validity in a large-scale survey.

The respondents were contacted via telephone and email to request for participating in the interview. There were 25 experts agreeing to participate in the research; however, the interviews were only able to be conducted with only 20 experts in 2 months (June 2016–August 2016). While most of the industrial practitioners were managers and senior staff with an average of 5 years' experience, the academic experts had more than 5 years of experience. The job title and job function of participants vary from field to field relating to SCC. The senior staff and manager occupy most of job title and these respondents are working at different fields relating to SCC.

In this study, because there were 20 participants, the minimum value of CVR of each component was 0.42 [52]. The result showed that all the experts agreed with the level definitions and process requirements of each level (CVR value greater than 0.42). However, there were seven sub-processes with the CVR below 0.42, which were considered as not suitable for considering the relationship between manufacturers and customers in the Vietnam textile and apparel industry context. The seven eliminated sub-processes are also shown in "Appendix 1" with the sign "*" for clarity. These eliminations were explained during the interview and consistent with the analysis of the Vietnamese context background of manufacturing and outsourcing contracts for international customers. After

eliminating seven sub-processes, the final MM-SCC model was built for the Vietnamese textile and apparel industry.

4.2 Case application

4.2.1 Collaboration maturity level

Prior to each interview, the respondents are informed regarding the purpose of the study and the model is explained. Because there is no rank or title of supply chain manager at both companies, the research is conducted at different departments of the company. Executives, managers or senior staffs of departments of sales, information system and enterprise resource planning (ERP), production, logistics and inventory, industrial (lean) engineering (IE) are interviewed based on the model. The respondents answer for the relevant fields. If the answer is different for the same process requirement, the disagreements are handled by follow-up another interview with more explanation and more documentary evidence provided. For “yes” answer, the evidence is provided, including documents, photos (posters), data and observations. Data collection for this study utilized multiple sources of evidence, including on-site interviews, observations and documentary to ensure both the reliability and construct validity for the study [57, 58].

The summary of model application is presented in Table 5. The detailed explanation along with evidence are given in “Appendix 2”.

ABC Company cannot meet all the process requirements of level 2 (there is “NO” answer at level 2); hence it is on level 1 in the scale. If the company cannot meet all the process requirements of a particular level, it cannot be on that level [54]. On the other hand, XYZ Company has performed and met all the process requirements of up to level 4; therefore, it has reached to the level 4 of the model. Each case performs a specific collaboration maturity level gauged by the MM-SCC model.

4.2.2 Performance

The KPIs of quality level, on-time-delivery and utilization are collected (Table 6). For XYZ Company, since it has built a very an effective performance measurement system, monthly KPIs reports of Production Department (quality level and utilisation) and Sale Department (on time delivery) are used for KPIs. For ABC Company, there is no KPIs report. Only raw data are recorded daily. The researcher collected the relevant data and analysed for the KPIs. The report of number of defects, the target quantity and actual quantity are used to analyse the quality level and utilization. On-time delivery is tracked based on the delivery

Table 5 Model results

Process requirements	ABC company	XYZ company
Level 1	N/A	
Level 2		
Managerial commitment and Strategic intent	Answer: Yes	Answer: Yes
Resource investment and development	Answer: Yes	Answer: Yes
Rationalisation	Answer: Yes	Answer: Yes
Internal alignment	Answer: No	Answer: Yes
Relationship and trust building	Answer: No	Answer: Yes
Information Flow and System Integration	Answer: No	Answer: Yes
Formalisation	Answer: No	Answer: Yes
Level 3		
Goal congruence	Answer: Yes	Answer: Yes
Decision synchronisation	Answer: Yes	Answer: Yes
Incentive alignment	Answer: Yes	Answer: Yes
Resource sharing	Answer: Yes	Answer: Yes
Joint knowledge creation	Answer: Yes	Answer: Yes
Collaborative communication	Answer: No	Answer: Yes
Information sharing	Answer: No	Answer: Yes
Level 4		
Performance measurement	Answer: No	Answer: Yes
Level 5		
Continuous improvement	Answer: No	Answer: No
SCC maturity level	Level 1	Level 4

Table 6 KPIs

Company	ABC					XYZ				
Customer	CMT		FOB	OBM	Average	US	Japan	US	Japan	Average
Product	Vest	Shirt	Vest	Shirt		T-shirt		Sweater		
Quality level % (final product)	94.18	78.62	88.32	83.58	86.18	98.2	99.81	97.95	97.56	98.38
On-time delivery %	78	74	70	85	76.75	99.40	99.5	96	98	98.225
Utilisation %	83.4	82.23	83.4	82.23	82.82	103.52	103.75	99.20	108.62	103.77

The tolerance of provided material is + 10% and XYZ makes use of all the materials. The overproduced quantity is negotiated with the customer for a special price

date and completed date for each order. Raw data can only be tracked back for 1 year.

5 Discussion

This section is to analyze the relationship between SCC and performance based on the results of model application. The effects of SCC on performance are evaluated quantitatively through KPIs and qualitatively through subjective assessment from managers to reconfirm and explain more for the effects. Furthermore, how internal and external relationship interact is also pointed out. Finally, the conclusion along with managerial implications is provided at the end.

5.1 SCC maturity level and performance

The quality level of ABC is low, lying within two-sigma with 86.18% compared to XYZ's quality level, which lies within three-sigma with 98.38%. The on-time-delivery percentage is certainly an important metric for customers; ABC Company's late delivery percentage is high with 23.25% compared to only 1.77% for XYZ Company. Further, the utilisation of ABC is much lower than 1 or 100% on the percentage scale, while XYZ's is always greater than 1. This proves that ABC Company's resource utilisation is inefficient. The poor-quality cost of high defects and airship cost will definitely raise the manufacturing cost for ABC Company. This will also result in ABC jeopardising their long-term relationship with customers.

Comparing between ABC and XYZ Company, it displays that a lower level of collaboration maturity level results in a lower performance level in their relationships. The positive outcomes of SCC have been declared with the majority of previous studies agreeing on the direct positive link between SCC and performance [59]. The results of the comparison between ABC and XYZ Company are consistent with the literature. We were able to build on the previous literature that the effects on the performance are

quantitatively and qualitatively measured through actual data of key performance indicators (KPIs).

5.2 Internal collaboration and performance

The differences in process requirements between two companies are analysed to explore the SCC phenomenon. Obviously, both companies meet the process requirements of managerial commitment and strategic intent, resource investment and development, rationalisation, goal congruence, decision synchronisation, incentive alignment, resource sharing and joint knowledge creation. It can be seen that these are intra-organizational processes to fulfil its customers' requirements. For a customer-driven commodity chain; customers' satisfaction is vital to the survival of an organisation and the core strategy of any organization. As such, it is incredibly important to ensure an effective external collaboration by working closely with customers and meet their requirements. All the organizations are pursuing customer relevant activities such as customer services.

The differences in SCC practices between two companies are presented in these process requirements—internal alignment, relationship and trust building, information flow and system integration, formalisation, information sharing, collaborative communication, and performance measurement. These are inter-organizational processes which are across functions in one organisation. This internal collaboration is usually considered under two dimensions—the integration of physical and information flows which is labelled as information integration and coordination of operational decisions [60]. Consistently with this classification, the observed differences between the two companies are information integration (information flow and system integration, information sharing or collaborative communication) with the application of ERP software and operations management (internal alignment) with managerial approach using lean manufacturing. The lack of intra-organizational integration is mentioned to be the cause preventing manufacturers to achieve the benefits of external integration and from fully impacting performance

[35, 61–64]. In other words, internal failure is a major barrier to SCC [65]. Literature has also shown that information integration [66–68] and operations management [69–72] have a direct and positive impact on performance. Successful collaboration requires effective internal alignment first, which is a key element for enterprises to engage with before extending the scope of integration outside [73].

Inevitably, since ABC Company does not meet the process requirements at level 2 that are antecedents for SCC, the process requirements at level 3 and 4 cannot be performed either. ABC has showed that it only focused on the inter-organizational processes and was having the problem with intra-organizational processes. The fact is that while focusing on the “appearance”, ABC fails to maximize the quality of their internals. The effects of internal collaboration with information integration and operations management on performance are also subjectively evaluated by managers such as:

“We have many wastes in production system such as high (WIP), high quality defects. The manufacturing system has many problems with very low-quality level, on-time-delivery and effectiveness compared to other companies in the industry.”—ABC Production manager.

“The rescheduling manufacturing is not timely made because the actual vs planned quantity is recorded at the end of day and sorted out the following day. Inventory system is not able to link with production system; hence, the materials are sometimes supplied to the plant and cause a lot of work-in-process (WIP).”—ABC Production manager.

5.3 Internal collaboration and external collaboration

Research shows that while most of the authors agree that internal integration is positively associated with operational and business performance of the manufacturer in a direct or indirect way, while external integration have been claimed to probably have the reverse impacts or no direct association with performance [12, 35, 74]. Additionally, it is pointed out that there is still a lack of research exploring how internal and external relationship interact [35, 75]. The link between them results being somewhat divergent [16].

To have an in-depth exploration on this, the within case analysis is conducted to examine the relationship among different customers in one case. To consider the external relationship with customer, the degree of involvement, influence in the company’s decision and level of strategic partnership with suppliers or follow-up with customers for feedback are evaluated by managers [76]. These are based

on the nature of production modality, and customers’ culture and policy. The results are summarized in Table 7.

In ABC Company, under the same product category—either vest or shirt, it can be seen from Table 6 that a higher level of external integration causes a negative effect on performances in both terms of quality level and on time delivery. For example, in the category of vest product, quality level and on-time-delivery of CMT Customer are 94.18% and 78% respectively, higher than 88.32% and 70% of FOB Customer even FOB Customer has a better relationship with the manufacturer. The phenomenon is similar under the shirt category between OBM and CMT. Here, two variables of external integration and performance have a negative association.

In contrast to previous case, in XYZ Company, it is seen that the customer with higher integration can create higher effectiveness for the operational system as demonstrated through the performance indicators in all aspects. Specifically, in either T-shirt or sweater category, Japanese customer with higher integration level can create a higher quality level in general, on time delivery and efficiency for the manufacturer (the surveyed period is noted with the change of workers in production line for Japanese customers; hence it created more defects than usual).

So, whether external integration is effective in enhancing firm performance or not. The reason of this inconsistency is provided by managers.

“The more involvement the customers have, the more defective items are identified. We are not capable enough to meet it at the first time. We must rework and solve and this leads to the low quality level and low on time delivery percentage.”—ABC Lean manager.

When the requirements are high, the company is not capable of handling those requirements and so it fails to meet the requirements. The lack of internal capability causes the adverse effect of external integration on performance. The XYZ Company, on the other hand, is at a high level of internal integration; so, the more integrated the company is with the customer, the higher the performance

Table 7 Customers’ external collaboration

Company	ABC			XYZ	
	OBM	CMT	FOB	US	Japan
Customer’s influence	Low	Medium	High	Medium	High
Customer involvement	Low	Medium	High	Medium	High
Feedback follow-up	Low	Medium	High	Medium	High
External collaboration level	Low	Medium	High	Medium	High

is. This positive correlation is explained by managers as below:

“Japanese customer has a very long-term relationship with us through long-term contracts, so we can build a standard and stable production system. While the US customers do not have regular orders and the product type is very different, so we must re-setup the system for different orders. This leads to the lower efficiency and effectiveness”.—XYZ Production manager.

The relationship between internal and external is mentioned in the literature that internal integration is regarded as the prerequisite for outside collaboration among trading partners in other findings [73, 77]. Internal integration positively generates external integration [78] or critical enablers/vital link facilitating the relationship between customer integration and supplier integration [35, 79]. Serving as a foundation of the external integration [73, 74, 77, 80], internal integration also has a moderating effect on the relationship of external integration and performance [12, 35, 74, 78, 79].

Consistent with literature, the results show that, with a good internal capability, XYZ is able to meet the customers' requirements. Therefore, the effective integration will enhance the stability and robustness for the system and link to performance. From the within-case analysis, these observations demonstrate the moderating role of internal integration in the relationship between external integration and the performance. If a system is well-integrated, the higher level of integration with customer will lead to higher performance. It is clearly seen from within-case of ABC Company, due to the lack of internal integration, even the higher level of external integration cannot bring higher performance for the company. XYZ Company has built an effective system; hence, it is able to pursue successful external collaboration with customers.

5.4 Managerial implications

The application of the model has shown that ABC Company, while focusing on the “appearance”, failed to meet the requirements of their internal. The results of this inefficiency are clearly indicated by ABC's KPIs. The key for managers is to understand that organizations should begin SCC with internal integration to build the foundation for customer and supplier integration [35, 62, 81]. It is also mentioned that a firm with customer-driven business should undertake work of integrating the firm internally to reap the fullest rewards [61]. Irrespective of how much effort a firm spends to find new customer or maintain a relationship, the research indicates that failure in internal integration is sufficient enough to cause the failures in

SCC. Capabilities of both internal and external integration are mentioned to be crucial to achieve better performance [81]. However, this is a common problem in the industry as is stated in the literature that many companies tend to only pursue external collaboration and often pay less attention to internal capability [82, 83].

These problems are rooted with the inefficiency in information integration and managerial approach. A lack of a fully implemented, effective information integration and management capability prevents companies from achieving a collaboration maturity level. In addition, this inefficiency also results in low performance measures. Firms should move effort toward increasing levels of communication and cross-functional activities [62, 84].

Along with managerial approaches, namely lean manufacturing, information systems, ERP in particular, provides the information and decision support to the management are also developed [85]. These have also received attentions from managers for operational excellence during the last decade [86]. Based on the fact that ABC Company has developed ERP and lean manufacturing activities, improvement scenarios for ABC Company are suggested with improvement activities for current systems which identify problems and propose solutions with a small-scale tuning of a system rather than developing a new approach.

Although MM-SCC serves the function of the benchmark rating method to compare the organization's capability to itself over time, in this study, these improvement activities have not been practically be applied for case study to examine the effects of these future scenarios on the performance. As such, longitudinal case studies considering how conditions change at different points in time after applying improvement activities with real data will contribute significantly to the existing body of knowledge. To serve this purpose, simulation approach is suggested to foresee the future scenarios.

6 Contributions and future direction

This study is a novel contribution that fills the gap of maturity models for effective use in the supply chain context [11, 14], particularly in SCC. The proposed model is a SCC process maturity model. The industry can use it as a guideline or a diagnostic tool to compare the organization's capability to others' and itself over time. By applying the model as a form of self-assessment, the enterprises can diagnose the current SCC practices of what have been done and what are missing. Once the root of the problems is found, improvement activities can be acknowledged to improve immature processes to a higher level.

This is the first application and validation of the MM-SCC model based on the data from the Vietnam textile and garment industry. The findings show the applicability and usefulness of MM-SCC. By applying the model, the managers can acknowledge the significance of information integration and operations management capability in order to achieve a higher level of collaboration maturity. This knowledge will enable managers to make strategic decisions to produce a better SCC for their organisation.

Secondly, this study contributes to the lack of empirical researches investigating the mechanisms of SCC and their effects on performance [21, 87], especially qualitative-based research such as in-depth case studies to enhance the understanding for this phenomenon in the real world. How higher levels of maturity lead to higher levels of performance is explored.

Thirdly, the study also fulfilled the need of the real data of the performance outcomes in examining the effects of SCC. The study provides evidence-based findings for the relationship between SCC and performance outcomes. Furthermore, industry-based research is conducted to contribute to the lack of how collaboration is adapted to particular needs [6].

MM-SCC model is still in its initial stage of development and there is further need to consider. Firstly, since the MM-SCC model is developed based on the findings from an extensive literature review on the topic of SCC; the

developed model should be applicable to other industries. However, as each industry has its own unique characteristics, the content validity is necessary before the model is applied in a specific context. This step will ascertain whether there are other factors that are crucial in the selection or application of the model.

Secondly, while the CMMI model supports two improvement paths using capability levels (for an individual process area) and maturity levels (for a set of related processes), the MM-SCC was only built to support the organisation with the maturity levels. This study did not consider the capability level of each individual process, but rather focussed on meeting a group of process requirements for SCC. Therefore, in future efforts need to be made towards completing the MM-SCC model by developing the capability level for individual process.

Last but not least, the present study is unable to analyse performance for a period of time. This study collected only a year performance data. This limitation is also mentioned in literature to explore the relationship using a longitudinal data. Hence, longitudinal study will be a promising area.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Appendix 1: Sub-process

Level	Process	Sub-process
2	Managerial commitment and strategic intent	Establish clear strategic intent [3] Obtain commitment from chief executive and support from senior functional management [30] Make the recognition of the need for collaboration widespread and visible through the organization [30]
	Internal alignment	Develop a supply chain mapping and role definition [3, 30] Streamline operations [3] Select supply chain partners [3]
	Resource investment and development	Invest financial and non-financial resources including time, money, training, technology up-dates, top management's commitment and other resources [3] Develop sharing learning mechanisms throughout the organization and the supply chain [30] Establish project teams, cross-functional management, and develop cross-experienced managers [30]
	Relationship and trust building	Source: [30]: Establish a high level of trust within the organization as well as with supply chain partners Find qualified product suppliers and service providers that are committed to continuous improvement Define the appropriate type of relationship to establish with specific supply chain members *Establish a supplier development program via process improvement and product development

Level	Process	Sub-process
3	Information flow and system integration	<p>Source: [30]:</p> <ul style="list-style-type: none"> Established information systems capable of sharing real time accurate and relevant information (connectivity) Inculcate a willingness to share information across functions and between organizations Establish a revenue-tracking system *Improve forecast accuracy throughout the entire supply chain
	Formalization	<p>Source: [30]:</p> <ul style="list-style-type: none"> Co-developing performance metrics (e.g. key performance index, scorecard, and the resulting incentive) Prior agreements on collaboration goals or objectives Determining roles and responsibilities of each partner as well as reporting Mechanisms in the relationship Laying out collaborative implementation plans Standardizing information technology Aligning collaboration schedules and Specifying information to be shared
	Rationalization	<p>Source: [30]:</p> <ul style="list-style-type: none"> Identify and take advantage of commonalities and collaborative improvement opportunities Simplify the network—supply base, customer base, and service provider reduction Eliminate unnecessary or slow moving SKUs
	Information sharing	<p>Source: [8]</p> <ul style="list-style-type: none"> Exchange relevant information Exchange timely information Exchange accurate information Exchange complete information Exchange confidential information
	Decision synchronization	<p>Source: [8]</p> <ul style="list-style-type: none"> Jointly plan on promotional events Jointly develop demand forecasts Jointly manage inventory *Jointly plan on product assortment *Jointly work out solutions
	Incentive alignment	<p>Source: [8]</p> <ul style="list-style-type: none"> Share costs (e.g. loss on order changes) Share benefits (e.g. saving on reduced inventory costs) Share any risks that can occur in the supply chain Be commensurate with investment and risk
	Goal congruence	<p>Source: [8]</p> <ul style="list-style-type: none"> Have agreement on the goals of the supply chain Have agreement on the importance of collaboration across the supply chain Have agreement on the importance of improvements that benefit the supply chain as a whole Have agreement on achieving goals through working towards the goals of the supply chain Jointly layout collaboration implementation plans to achieve the goals of the supply chain
	Resource sharing	<p>Source: [8]</p> <ul style="list-style-type: none"> Use cross-organizational teams frequently for process design and improvement Dedicate personnel to manage the collaborative processes Share technical supports Share equipment (e.g. computers, networks, machines) Pool financial and non-financial resources (e.g. time, money, training)
	Collaborative communication	<p>Source: [8]</p> <ul style="list-style-type: none"> Have frequent contacts on a regular basis Have open and two-way communication Have informal communication Have many different channels to communicate Influence each other's decisions through discussion rather than request
	Joint knowledge creation	<p>Source: [8]</p> <ul style="list-style-type: none"> Jointly search and acquire new and relevant knowledge Jointly assimilate and apply relevant knowledge *Jointly identify customer needs *Jointly discover new or emerging markets *Jointly learn the intentions and capabilities of our competitors

Level	Process	Sub-process
4	Performance measurement	Source: [30] Establish a routine process involving: daily capacity planning meetings; monthly KPI status review; quarterly executive business reviews; and continual up-dating of key metrics/goals Design a proactive supplier scorecard-based rating system to drive continuous improvement
5	Continuous improvement	Source: [30] Organizational collaborative improvement initiatives Benchmark

*Eliminated sub-processes

Appendix 2: Model results

Process requirements	ABC company	XYZ company
Level 1	N/A	
Level 2		
Managerial commitment and Strategic intent	Answer: Yes Clear missions and vision have been established. These clearly indicate the commitments and supports from executives and managers to meet customers' expectations	
Resource investment and development	Answer: Yes Financial and non-financial investments to develop human resource (such as training programs) and facilities (such as latest technological equipment or ERP system)	
Rationalisation	Answer: Yes By clearly defining the role in the chain, the appropriate type of production which is "make-to-order" with no-finished good inventory have been clearly defined. The company's chain is simplified based on the customer with assigned suppliers and service providers	
Internal alignment	Answer: No IE department was established in 2013 to implement Lean manufacturing in order to reduce waste; however, it only performed at the very three first steps of 5S tool The resultant inefficiency is apparent from on-site observations at ABC Company, with a high rate of work-in-process (WIP), defects or stoppages	Answer: Yes IE department has been established from the company's beginning. Lean manufacturing has successfully been applied using many tools, such as 5S, Kaizen, Kanban or Continuous Flow
Relationship and trust building	Answer: No Customers must send a third-party to carry out product inspections at ABC Managers explain the reason for this distrust as follows: <i>"Company is losing many customers and struggling to find new ones. We cannot meet the high requirements of big customers because of an ineffective manufacturing system. The current customers must send their representatives to our system to jointly manage the manufacturing process. We are not able to conduct self-inspection."</i> – ABC Lean manager	Answer: Yes XYZ has achieved factory self-inspection and meet customers' audit with high standard. XYZ has long-term relationships with customers
Information Flow and System Integration	Answer: No ERP system has been established for three years. ABC has developed its own basic modules for the ERP system, such as Purchase, Human Resource, Inventory, Sales and Marketing, and Production. Modules for Finance and Accounting and Customer Relationship Management (CRM) have not been developed yet. Each module works separately and performs its own data-processing function, and they do not constitute an ERP integrated platform. Paper documentation is used to complete processes and reporting	Answer: Yes XYZ Company has developed a world-class SAP ERP application to access high quality data and boost productivity, efficiency and profitability Modern techniques with RFID on production shop-floor to plan, track, monitor and manage order status, quality and progress in real time Electronic Data Interchange (EDI) is linked with customers. XYZ has connected its ERP system with customers

Process requirements	ABC company	XYZ company
Formalisation	<p>Answer: No</p> <p>ABC Company has not built these rules yet, so a willingness to share information is still limited because the staffs do not know what to do and they are afraid of the responsibility</p> <p><i>"If we need data for requesting analysis, we do not know which department is in charge of it and where to ask for. Therefore, without a clear specification of information to be shared, it takes time and efforts have complete and accurate information."</i> – ABC Lean manager</p>	<p>Answer: Yes</p> <p>XYZ has clear rules for information sharing with a responsible person or department; type of information shared and so on. These rules are documented</p> <p>Therefore, the sharing information culture is also established because the staffs are aware of their roles as well as their responsibilities. Especially, confidential information such as information of special design or technique is also shared based on commitments and trust</p>
Level 3		
Goal congruence	<p>Answer: Yes</p> <p>ABC and XYZ are members of the Vietnam Textile and Apparel Association (VITAS) and responsible for the integration and growth of the Vietnam's textile and apparel sector. Both companies have agreements on collaboration among partners which are ruled by meeting the customers' satisfaction</p>	
Decision synchronisation	<p>Answer: Yes</p> <p>Processes of decision synchronization and incentive alignment are presented through jointly working out on solutions on delivery date, on late delivery (such as expanding the due date or sharing cost for airship) or for sampling development and so on</p>	
Incentive alignment		
Resource sharing	<p>Answer: Yes</p> <p>Resource sharing is made between company and customers including technical supports, jointly searching and acquiring new techniques for product design and production or jointly managing the production process. Customers send their representatives to the manufacturers during production time to support and timely solve the problems</p>	
Joint knowledge creation		
Collaborative communication	<p>Answer: No</p> <p>The lack of ability and capability to collaborate (level 2) leads to insufficient Information Sharing and Collaborative Communication. This incomplete reporting does not occur in real time, increasing the chances of contradictory data that causes redundancy. ABC is not able to exchange information timely and accurately within the organization as well as with partners [52]</p> <p><i>"Sale department is not updated with the current production capacity status; so when we negotiate the due date for an order, we make decision based on the planning documents. This can cause the wrong date and lead to the late delivery."</i>—ABC Sale manager</p>	<p>Answer: Yes</p> <p>By creating the ability and capability for organisation to share information, has exchanged relevant, timely, accurate and complete information within the company and the operations are very smooth and problems are solved very quickly</p>
Information sharing		
Level 4		
Performance measurement	<p>Answer: No</p> <p>Performance measurement has not yet been established at ABC. At the moment, raw data have been recorded in the electronic system; however, they have not been analysed for management purpose yet [52]</p> <p><i>"Raw data is recorded but have not been used for any analysis to evaluate the performance. Improvement activities cannot be conducted because we are trying to standardize the system."</i> – ABC Lean manager</p>	<p>Answer: Yes</p> <p>XYZ has built a very good KPI system, which is customers' requirement for auditing for each department. Data are processed daily and meetings are held weekly to continuously up-date key metrics/goals:</p> <p><i>"We establish goals for productivity, measure through KPI and manage the system quantitatively. Continuous improvement Kaizen is constantly performed."</i>—XYZ IE manager</p>
Level 5		
Continuous improvement	<p>Answer: No</p> <p>Continuously improving collaboration capability has not been recorded in practice [23], and as such level 5 is considered as an ideal level for the industry. In this study, XYZ has not performed activities of level 5 for SCC process yet</p>	
SCC maturity level	Level 1	Level 4

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