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Discussion Paper No.149

Why and how firms conduct specific supply chain integration strategies? Considering the configurations of the customer order decoupling point and supply chain integration

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Nov. 17, 2023

TOHOKU MANAGEMENT & ACCOUNTING RESEARCH GROUP

Discussion Paper

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Why and how firms conduct specific supply chain integration strategies? Considering the configurations of the customer order decoupling point and supply chain integration

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Abstract
This study develops a theoretical framework of the supply chain integration (SCI) strategy selection in manufacturing industries which use custom parts. Then, it examines the framework by collecting data from dealers, manufacturers, and suppliers in three Japanese motorcycle supply chains in Vietnam. The empirical evidence shows that customer order decoupling point (CODP) positioning and SCI implementation should always be considered together, not separately. To achieve organizational strategic objectives and improve operational performance, selecting suitable configurations of CODP and SCI strategy is important. Generally, using full SCI combined with make-to-order (MTO) approach demonstrates superior performance, achieving both efficiency and flexibility. However, demand volume and demand volatility are market factors that influence the feasibility of CODP and SCI configurations. When suppliers use MTO, the prerequisite for MTO with full SCI at manufacturers is that demand volume must be big enough to ask for supplier integration (SI). In other words, SI is an enabler for MTO at manufacturers when suppliers use MTO; and SI is constrained by demand volume. When manufacturers can use MTO with full SCI, demand volatility then affects the level of SCI and consequent performances. Specifically, when demand volatility is high, the level of SCI needs to be increased, but the risk of instability in production and labor allocation also increases.

Keywords: supply chain integration, customer order decoupling point, production planning, operational performance, Vietnam

1. Introduction

The study on supply chain integration (SCI) is essential and draw increasing attention among researchers (Wiengarten et al., 2016; Khanuja & Jain, 2019). The desire to improve and respond to increasing uncertainty prompt organizations to make SCI with their supply chain (SC) partners (Khanuja & Jain, 2019). The integration of sales, production, and procurement is believed to facilitate the seamless information processing throughout the supply chain, which improves quality-cost-delivery and flexibility performance (Wong et al., 2011). However, SCI is not effective and applicable to all firms in the same way (Shou et al., 2018). SCI is also complicated and involves inter-firms' efforts, costs, and risks (Wong et al., 2015). So far, there are some problems that yet to be solved in SCI research.

Although the area of SCI is mature, most of studies focus on SCI-performance, and factors affecting SCI type and level (Flynn et al., 2010; Wong et al., 2011; Wong et al., 2015; Khanuja & Jain, 2019). Surprisingly, there is no single study examines why and how firms select a specific SCI strategy. Meanwhile, this study is utmost important to deeply understand the SCI process and provide implications for SCI implementation. The lack of understanding the SCI strategy selection process may affect the research settings in prior studies and become the reason for inconsistent results of SCI performance. For examples, some researchers found the positive effect of customer integration (CI) on operational performance (Frohlich and Westbrook 2001; Droge et al. 2004), but others showed no significant effect (Devaraj et al., 2007). Or while some found positive effect of supplier integration (SI) on efficiency (Devaraj et al., 2007; Prajogo & Olhager, 2012), others found significantly negative relationship (Abdallah et al., 2014). Until recent years, van Donk & van Doorne (2016) explored different customer decoupling points (CODP) locations may use different SCI types and levels to achieve the organizational goals. Particularly, make-to-order (MTO), make-to-stock (MTS), and assemble-to-order (ATO) firms use relatively high integration levels in upstream, downstream, and internal dimensions, respectively (van Donk & van Doorne, 2016). Therefore, we would expect that considering CODP positioning may help to develop the framework to investigate the SCI strategy selection and implementation process.

Besides, prior studies also face common limitations in data collection. Most studies either used the data of manufacturers (Lu et al., 2018; Zhao et al., 2011), or suppliers (van Donk and van Doorne, 2016), or data of random manufacturers and suppliers not in the same SC (Munir et al., 2020) to build the constructs for SCI. These settings are not sufficient (Wikner & Bäckstrand, 2018), and provided very limited insights into a firm's SCI strategy selection process. Regarding context, prior studies majorly collected data from developed countries (Tsinopoulos and Mena, 2015) or China (Lockstrom et al., 2011; Khanuja & Jain, 2019). Thus, it is necessary to conduct more research in other emerging markets to verify the arguments in prior studies (Khanuja & Jain, 2019).

To fill the above research gaps, this study collects data from suppliers, manufacturers, and dealers of the same supply chains in an emerging country to answer the research question: *why and how are firms using specific SCI strategies in terms of production planning?*

To implement the research purpose, we firstly review the literatures of CODP and SCI to develop the theoretical framework of SCI strategy selection process. Then, we use the multiple case study of Japanese motorcycle supply chains in Vietnam to visualize the SCI process and discuss the answer to the research question. The case selection was driven by its relevance to the study purpose and the SCI research. Japanese motorcycle supply chains in Vietnam were confirmed to have characteristics of SCI such as intensive information sharing for Just-in-time (JIT) production (Mishima, 2010; Fujita, 2013; Ngan, 2020b). Thus, they are appropriate for the SCI research. The three Japanese manufacturers concerned together account for more than 90% of the market share. The small number of major players representing the industry provides a good opportunity for in-depth research. Moreover, Khanuja & Jain (2019) reviewed 110 papers and called for more studies in emerging markets. The motorcycle industry is an industry whose production and market centers are in emerging countries, and Vietnam's motorcycle industry is the World's fourth largest in terms of market size and production scale (Marklines, 2022). Vietnam is also among the fastest-growing economies (The Harvard Gazette, 2023), which is worth the attention. Meanwhile, its context is not mentioned in prior studies (Khanuja & Jain, 2019). Different from the contexts in prior studies on SCI, the uncertainty in Vietnam is considerably high with counterfeit parts, unique market characteristics (Ngan, 2020a), and frequent changes of industrial policies (Mishima, 2010; Fujita, 2013; Kawabata, 2015). The important position in emerging markets and high uncertainty environment makes Vietnamese context useful to supplement our understanding of SCI.

With the above case selection, this study deals with the supply chains of manufacturing industries whose core components are custom parts. In such SCs, suppliers of key components have to use MTO (Mishima, 2010; Fujita, 2013). Throughout the paper, we consider this constraint while analyzing SCI strategies. Since the industries using custom parts occupy a very important position in the manufacturing industry, the theoretical significance is not compromised.

Like previous research, this SCI study adopts organizational information processing theory (OIPT) (Shou et al., 2018). Accordingly, it will investigate an information-processing system between manufacturers and external SC partners coping with task interdependence to respond to market requirements. The originality of this study is to provide the theoretical framework and the visualization of SCI processes between suppliers, manufacturer, and dealers. Based on that, it analyzes the case studies and draw implications. The results of this study show that (1) CODP positioning and SCI implementation should always be considered together, not separately; (2) the operational performance is different between configurations of CODP and SCI strategy; (3) demand volume and demand volatility are the constraints on the feasibility of CODP and SCI configurations; (4) When suppliers use MTO approach, supplier integration (SI) is an enabler for MTO at manufacturers; however, (5) SI is constrained by demand volume. Based on these findings, the managerial implications are also discussed at the end of the study.

2. Literature review

2.1. Supply chain integration (SCI)

Regarding the definition of supply chain integration (SCI), the organizational information processing theory (OIPT) approach sees SCI as an open system that emerges when core firms need an information processing mechanism to coordinate many different tasks between intra- and inter-organizations (Galbraith, 1974; Shou et al., 2018). Information integration is the core of SCI and a foundation for integration of physical flows between SC partners (Sahin and Robinson, 2005; van der Vaart & van Donk, 2004; Prajogo & Olhager, 2012). The purpose of SCI is to reduce uncertainty and maximize the value for the end users at high speed and low cost (Flynn et al., 2010). Based on this definition, this study will investigate the information sharing and coordination process between SC partners to answer the research question.

Generally, SC researchers encouraged the investigation of three dimensions of SCI, including internal integration (II), supplier integration (SI), and customer integration (CI) (Flynn et al., 2010; van Donk & van Doorne, 2016). II relates to information synchronization between internal functions and collaboration between internal departments. II is the foundation for external integration (Flynn et al., 2010; Zhao et al., 2011). CI and SI mean the collaborative and synchronized processes between a core firm and its key customers and suppliers respectively (Flynn et al., 2010). Specific features of SI, CI, II discussed in prior studies are summarized in Table 3 (section 4) and are used to illustrate the SCI activities of each case in this study. In this study, three dimensions relate to triad supplier-maker-dealer relationship. Since dealers are direct customers of makers in automotive industries, maker-dealer dimension is the customer dimension.

2.2. Customer order decoupling point (CODP)

Traditionally, customer order decoupling point (CODP) is where a specific customer order is involved in the *production or delivery stage* (Giesberts & van der Tang, 1992; Hoekstra & Romme, 1992; Olhager, 2003). CODP is also considered as a main stock point, which buffers against demand fluctuations (Wikner & Johansson, 2015). Different CODPs lead to different master planning levels (Olhager, 2003, 2010). Make-to-stock (MTS) focuses on standardization and the economy of scale to reduce production cost and delivery lead times; however, it faces inventory risks if the forecast is inaccurate. In contrast, make-to-order (MTO) focuses on customization and the responsiveness to demand changes, reduces inventory risks, but faces long delivery lead times and reduced economies of scales. Assemble-to-order (ATO) is an alternative to MTS when parts and components are fabricated in advance, but final assembly line is delayed until receiving customers' orders. Compared to MTS, inventories of progressing parts at ATO are less costly than finished products (Olhager, 2010). There are obvious tradeoffs between the flexibility and reduced inventory risks of MTO versus production efficiency and short delivery lead times of MTS. Engineer-to-order (ETO) is when customer order is involved in the engineering and design stage. However, ETO is considered as a special case of MTO because the material flows of ETO and MTO are considered identical from the SC perspective (Olhager and Prajogo, 2012).

There is also an extended framework of CODP including production dimension and engineering dimension to explain the cases where some engineering adaptations are made to customer orders (Wikner & Rudberg, 2005). However, as Japanese motorcycle manufacturers only apply engineer-to-stock in Vietnam (i.e., product design already exists before a firm receive customers' orders), we only focus on the production dimension of CODP (i.e., MTO, ATO, MTS).

2.3. Relationship between CODP positioning and SCI implementation

Although SCI field is mature, it is surprisingly hard to find a study on SCI implementation process. Reviewing 110 SCI papers in major journals, Khanuja & Jain (2019) found that tremendous studies focus on enablers, SCI-performance link, and contingency factors on SCI- performance. However, extant studies do not explicitly investigate the SCI process or illustrate the relation between SCI dimensions and enablers of SCI (Khanuja & Jain, 2019). Thus, there is a lack of the thorough understanding of why and how firms implement a specific SCI strategy. When scrutinizing the literatures, we found some arguments that SCI is used to reduce uncertainty to enable postponement and customization in SC design (Yang & Burns, 2003; Mikkola & Skjøtt-Larsen, 2004). Meanwhile, postponement is closely related to CODP positioning, which is the strategic consideration when designing and managing SC operations (Olhager, 2010). Therefore, we extensively review the studies on the relationship between CODP and SCI.

The choice of CODP is affected by the demand volatility and the ratio between production lead times and required delivery lead times (Olhager, 2003). The ratio between required delivery lead times (D) and production lead times (P) were first identified as D/P relation (Shingo, 1981), then was changed as P/D ratio for practical reasons (Mather, 1984; Olhager, 2003), and finally S/D ratio to reflex the more general supply lead time (Wikner, 2014). The supply lead time S is the total production lead times considering supplier lead times (i.e., purchasing parts and delivery from suppliers) (Wikner & Rudberg, 2005; Sun et al., 2008; Wikner & Johansson, 2015; Wikner & Bäckstrand, 2018). If S is shorter than D, MTO become feasible because all activities can be conducted within the time required by customers (Wikner, 2014). However, if S is longer than D, MTO is not feasible, so firms have to choose MTS or ATO and perform some activities before receiving customer orders (Wikner, 2014).

Conceptually, Yang & Burns (2003) discussed the importance and implications of postponement for CODP positioning. According to their arguments, postponement encourages a new way of thinking regarding product design and inter-firm process design. This is because when considering postponement, firms must decide which components would be standard or customizable, which SC partners would do each task, what activities are forecast-driven or customer order-driven, and where inventories would be located. In their arguments, SCI is considered as an enabler for postponement implementation. On the other hand, postponement helps locate the CODP. In this way, postponement implementation is closely related to CODP positioning and SCI strategy, however, they do not directly discuss the relationship between CODP and SCI.

The subsequent empirical studies finally provided some hints. Using two cases, van der Vaart & van Donk (2004) argued that upon order-winning criteria (i.e., cost or flexibility), firms can choose MTS or MTO and stage of integration (i.e., shared resources without commitment or integrative planning stage). Compared to MTS, MTO firms often require higher supplier integration (SI) levels to cope with uncertainties. Based on observing a supply chain consisting of a vendor and a manufacturer, Sahin and Robinson (2005) examined the performance of SI in an MTO system by using a mathematical model and simulation approach. They found that in MTO systems, SI through information sharing and inter-organizational physical flow coordination helps to substantially improve cost performance of the whole supply chain. Olhager and Prajogo (2012) compared the performance of improvement initiatives between MTO and MTS firms and also found that SI significantly improves the performance for MTO, but not for MTS plants. On the other hand, internal process improvement initiatives significantly improve performance for MTS, but not for MTO. Van Donk and van Doorne (2016) empirically investigated the impact of CODP location on SCI type and level. They explored that MTO, ATO, and MTS firms have relatively high levels of SI, II, and CI, respectively.

Table 1: Research gaps

	Research Focus	Methods	SCI	CODP	Data	Context
Yang & Burns (2003)	Implications of postponement for CODP positioning, SCI, SC control, capacity planning	conceptual	SI, CI, II	MTO, MTS, ATO	-	-
van der Vaart & van Donk (2004)	The concepts of integration, shared resources and buyer focus	Conceptual & two examples	SI	MTO, MTS	2 S	-
Sahin and Robinson (2005)	The performance of SI in an MTO system	mathematical model & simulation	SI	MTO	1M, 1S	industrial drilling equipment
Olhager & Prajogo (2012)	Compared the performance of improvement initiatives between MTO and MTS firms	survey research	SI	MTO, MTS	216 M	various industries in Australia
van Donk & van Doorne (2016)	Impact of CODP location on SCI type and level	a multiple case study	SI, CI, II	MTO, MTS, ATO	12 S	Dutch metal part processing industry
This study	Considering CODP and SCI configurations and their performance	a multiple case study	SI, CI, II	MTO, ATO	3M, 7S, 17D	Vietnamese motorcycle industry

M: maker, S: supplier, D: dealer

Together these studies importantly suggested that SCI strategy selection may be impacted by the CODP location (Van Donk and van Doorne, 2016). However, these studies face some limitations. Yang & Burns (2003) is a conceptual study and not directly link CODP and SCI (Table 1). For empirical research, early studies do not consider SI, CI, and II together (van der Vaart &

van Donk, 2004; Sahin and Robinson, 2005; Olhager and Prajogo, 2012), while later ones do not examine the performance of the integrative efforts (van Donk and van Doorne, 2016) (Table 1). Besides, their studies were based on data collected from single respondent of each firm, or from one-sided SC member to build construct for three-dimensioned supply chains (Table 1). This may potentially result in limited insights or even biased results. Furthermore, they were conducted in developed countries (Table 1).

Addressing these research gaps, this study will examine the process of SCI strategy selection and evaluate performance to answer the research question on why and how firms implement specific SCI strategies. To overcome the limitations in prior research, this study collects data from suppliers, manufacturers, and dealers from the same SCs in an emerging market context (Table 1).

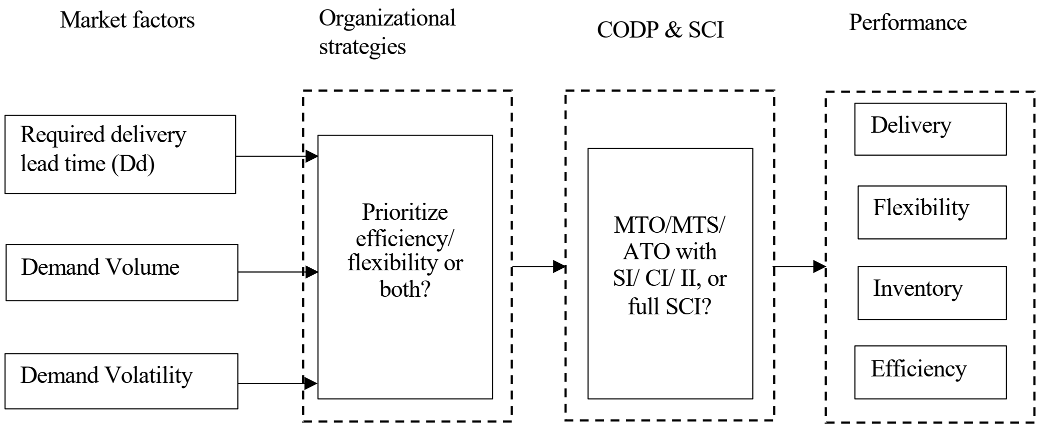
2.4. Theoretical framework and measurements

Since SCI is considered as an enabler of postponement implementation (Yang & Burns, 2003; Mikkola & Skjøtt-Larsen, 2004), SCI strategy may be affected by the CODP decision. Based on hints from prior studies, we propose the process as follows.

At first, firms need to define the organizational strategic objectives based on market characteristics and order-winning criteria (van der Vaart & van Donk, 2004). Firms may prioritize delivery speed and cost (efficiency) or the responsiveness to demand changes (flexibility). Based on that, firms will choose the most suitable CODP (van der Vaart & van Donk, 2004). Specifically, when firms face relatively high uncertainty or demand volatility, MTO is a natural choice to postpone production until receiving customers' orders (Olhager, 2003; Pereira et al., 2022). In low uncertainty situations and delivery speed and cost are the main order-winning, MTS or ATO is more appropriate (Olhager, 2003). When firms need to move towards MTO to increase flexibility, they need to increase postponement. For postponement to work, firms need to implement SCI to reduce uncertainties to ease the flow of information and materials (Yang & Burns, 2003; van der Vaart & van Donk, 2004). Conceptually, internal integration (II), supplier integration (SI), and customer integration (CI) are required to reduce process uncertainty, supplier uncertainty, and demand uncertainty respectively (Yang & Burns, 2003).

Figure 1 is established based on the above arguments: market factors affect organizational strategic objectives, which in turn affect the CODP location and SCI strategy at the core firms (i.e., manufacturers in this study). Regarding market factors, required delivery lead time, demand volume, and demand volatility are the most agreeable factors directly affecting the organizational goals and CODP location (Olhager, 2003; Aktan & Akyuz, 2017; Tookanlou & Wong, 2020). Organizational strategic objectives relate to whether firms want to prioritize efficiency or flexibility. Based on that, firms will choose CODP location and SCI strategies (Figure 1).

As mentioned, CODP location is constrained by the ratio between supply lead times and required delivery lead times- S/D ratio (Wikner, 2014). However, different from prior studies, this study considers three dimensions, so supply lead time S is not appropriate to use. Since there are multiple CODPs along the supply chains (Yang & Burns, 2003; Sun et al., 2008), we need to clearly separate lead times into dealers' required delivery lead times (Dd), makers' production lead times (Pm), and suppliers' production lead times (Ps). As this study focuses on the industries whose core components are custom parts and key suppliers employ MTO, so Ps<Pm is the premise. Then, Ps<Pm<Dd becomes the necessary condition for MTO to be feasible at both suppliers and makers. When Ps<Pm and Pm>Dd, MTO is not feasible for manufacturers. In this triad, we assume that makers' CODP positioning (MTO, MTS, ATO) are not only affected by dealers' Dd but also by suppliers' CODP location and production lead times (Ps).



Note: CI = customer integration, II = internal integration, SI= supplier integration, full SCI = CI + II + SI

Figure 1: The SCI strategy selection process at the core firms

Furthermore, we also assume that firms can flexibly change their CODP positioning using SCI and postponement. This is because the empirical evidence from Japanese automotive, steel, electrical appliance, and semiconductor industries show that firms can change the priorities between flexibility and efficiency by adjusting LSP (the lot size of planning) and LLS (the length of lead time for scheduling before production) (Okamoto, 2003) (Figure 2). LLS and LSP are measured by days. Firms can prioritize flexibility by shortening LLS and LSP and dividing monthly production into weekly production where market changes can intrude. In contrast, firms can utilize economies of scale by expanding LLS and LSP (Okamoto, 2003). We use LLS and LSP to measure Dd, Pm, and Ps. Different from the terms used in production, dealers' LLSd represents how far the order must be finalized before the first delivery. Dealers' LSPd represents the order lot size. Pm consists of makers' LLSm and LSPm. Makers' scheduling lead time (LLSm) is counted from the day of fixing production planning to the first production day. LLSm is the time necessary for manufacturers to prepare manpower, machines, input, testing staff, and arrange production lines. LLSm is vital to production and should be included in production lead times. Similarly, Ps consists of suppliers' LLSs and LSPs.

$$Dd = LLSd + LSPd$$

$$Pm = LLSm + LSPm$$

$$Ps = LLSs + LSPs$$

Decomposing lead times as above help us to measure exactly the lead times and illustrate the coordination process between suppliers, makers, and dealers.

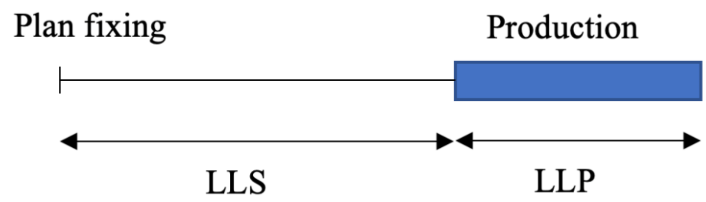


Figure 2: LLS and LSP indexes based on Okamoto (2003)

We assume that SCI-performance may be different between CODP and SCI configurations (Figure 1). As mentioned, each CODP location has different organizational objectives and consequently different utilization of SCI strategies (van der Vaart & van Donk, 2004; van Donk & van Doorne, 2016). MTO firms rely heavily on suppliers' quality-cost-delivery performance to deliver customized products at the speed and cost required by the market. Therefore, supplier integration (SI) plays important role to the performance of MTO firms (Olhager & Prajogo, 2012; Van Donk and van Doorne, 2016). Meanwhile, MTS firms compete on price and delivery performance of standardized products. ATO firms increase their competitiveness of price and minor flexibility of customized products (Pereira et al., 2022). MTS and ATO firms often have arm-length relationship with suppliers and less requirement for SI (Sahin and Robinson, 2005; Olhager & Prajogo, 2012; Van Donk and van Doorne, 2016). Instead, MTS rely on CI to improve forecast accuracy while ATO firms rely on II to solve the internal complexity and combine MTS parts production with MTO assembly (van Donk and van Doorne, 2016). In this way, different use of SCI strategy may lead to different performance between MTO, MTS and ATO. In this study, we will evaluate the performance of specific SCI strategies in terms of delivery, flexibility, inventory control, and production efficiency (Figure 1). These performance indicators are commonly analyzed in prior studies (Tomino et al., 2009; Wong et al., 2011).

Based on this theoretical framework (Figure 1), we collect data from dealers, manufacturers, and suppliers to illustrate the SCI process and explain why and how firms select and implement specific SCI strategies. We also evaluate performance to draw valuable implications.

3. Methodology

3.1. Research design

We apply an embedded multiple case study with inductive reasoning because it is appropriate to answer the question "why" and "how" (Eisenhardt, 1989; Yin, 2003). A semi-structured interview was adopted because it allows the adoption of both rigorous guidelines based on literature reviews and space for new questions that emerge in the field trips (Cohen and Crabtree, 2006). This design has the advantage to explore the insights into SCI processes and reasons for SCI strategy selection (van Donk and van der Vaart, 2004). Thus, it is popularly deployed for exploratory research in the SC field (Bevilacqua et al., 2012; Kobayashi et al., 2017; Lockstrom et al., 2011).

3.2. Case selection and data collection

The supply chains of Japanese motorcycle manufacturers in Vietnam are selected as units of analysis. Sub-units of analysis are dealers, manufacturers, and suppliers. The dealer interview list was sorted from makers' authorized dealer lists published on their websites. Long-standing dealers were chosen to obtain the data related to SCI and rich information about market characteristics. The supplier interview list was sorted from the lists of suppliers in Vietnam published on the websites of the Vietnamese government and the Japan External Trade Organization (JETRO). We sorted out tier 1 suppliers based on the "main customers" category in these lists.

Three manufacturers are A, B, and C (Table 2). All were headquartered in Japan but had motorcycle assembly plants in Vietnam. Exclusive dealers of all manufacturers are local businesses in Vietnam. The core part suppliers of manufacturers A and B were located in Vietnam, while those of manufacturer C were mainly located in countries other than Vietnam. The proximity facilitates the short logistic delivery time of parts from suppliers to manufacturers A and B's factories and of completed motorcycles from all manufacturers to local dealers.

Data collection was conducted four times from 2015 to 2018 (Table 2). We started by investigating local markets and interviewing dealers in 2015. The first data were analyzed and reported in many seminars and workshops, which resulted in the necessity for the second round of data collection. In 2016, we randomly visited the dealers and asked for research interviews. We stopped the data collection when all data were confirmed consistently, and no new information emerged. Interviews were conducted in Vietnamese and lasted between 30 minutes and 2 hours. Most of dealers' respondents were managing daily businesses and provided rich insights. 17 interviews with authorized dealers are used in this paper (Table 2).

Table 2: Profiles of interviewed firms

<table>
<tr><th>Name</th><th>Main products (production volume*)</th><th>Main customers</th><th>Interview date</th><th>Interviewees' positions</th></tr>
<tr><td>Maker A</td><td>Motorcycle (approx. 2,560,000 units)</td><td rowspan="3">exclusive dealers</td><td>Aug 28, 2017 & Aug 27, 2018</td><td rowspan="2">Managers of Production, Planning, Sales, Purchasing, Accounting & Finance, IT, Logistics, Business Administration departments</td></tr>
<tr><td>Maker B</td><td>Motorcycle (not discrete)</td><td>Aug 29, 2017 & Aug 28, 2018</td></tr>
<tr><td>maker C</td><td>Motorcycle (approx. 24,000 units)</td><td>Aug 30, 2017 & Sep 04, 2018</td><td>CEO & production manager</td></tr>
<tr><td>4 suppliers of A</td><td rowspan="2">sprocket, chain; lighting system; body & chassis; suspension; brake system; wheel & muffler</td><td>A is taking 50 -93% of sales</td><td rowspan="3">Aug -Sep 2018</td><td rowspan="3">CEOs, Sales managers</td></tr>
<tr><td>2 suppliers of B</td><td>B is taking 50-95% of sales</td></tr>
<tr><td>1 supplier of C</td><td>gears</td><td>C is taking 30% of sales</td></tr>
<tr><td>9 dealers of A</td><td rowspan="3">Motorcycle products, spare parts, after sales service</td><td rowspan="3">end-users</td><td rowspan="3">Aug 2015- Mar 2016</td><td rowspan="3">Owners, CEOs, finance managers, mechanic heads, accounting staffs</td></tr>
<tr><td>5 dealers of B</td></tr>
<tr><td>3 dealers of C</td></tr>
</table>

* Production volume is in 2018.

For makers and suppliers, we sent postal letters including a request for cooperation, a research purpose, and a question list to the CEOs of Japanese firms in Vietnam. In 2017 and 2018, we got acceptance from three Japanese manufacturers and seven suppliers. Respondents were a group of managers, including production, purchasing, and sales department managers (Table 2). They were the key persons in supply chain management and provided detailed information about each integration dimension. The languages used in the interviews were English, Japanese, and Vietnamese. It took approximately 90 minutes for interviews, and 90-150 minutes if factory tours were allowed. Notetaking and observation were allowed, but taking pictures inside factories and voice recording were prohibited (except for one recording with manufacturer A in 2017).

3.3. Data coding and analysis

We applied Eisenhardt's (1989) methods for coding and analysis for a multiple case study. During and after each interview, we checked and wrote descriptions in Word files. Then, we inputted quantitative data and coded qualitative data by categorizing the text into worksheets.

Quantitative data include LLS, LSP, Dd, Pm, Ps, inventory (measured by the number of days), production volumes, and bit time (i.e., the time gap between two finished motorbikes). They were used to develop tabular displays, map SCI processes, and elucidate a within-case SCI pattern. Then, SCI patterns and performance across supply chains were compared. Meanwhile, qualitative data were coded into worksheets and compared between cases to explore the reasons for SCI strategy selection.

Triangulation was conducted intensively in various ways. Data systematically recorded in worksheets were crosschecked between each manufacturer and their respective dealers and suppliers. Any inconsistent information was confirmed at the second interview with manufacturers in 2018. This helped to reduce errors or biases from both respondents and researchers. Data collection only ended when there was no inconsistent data. Secondary data were also used for triangulation, including published statistics, related reports, and online news. Finally, the drafts were sent back to respective makers and suppliers for their confirmation. The relevance of respondents, intensive triangulation, and confirmation from respondents together increased the validity and reliability of this study.

4. Results

4.1. SCI strategies: SI, CI, II, or full SCI?

Table 3 illustrates that supply chains A and B have full SCI, meanwhile supply chain C only has customer integration (CI) and internal integration (II). Supply chains A and B have similar integration features and have more integrative efforts of II and CI than supply chain C (Table 3). There is no product development function in Vietnam. Therefore, some features of internal integration and supplier integration related to product development were not observed (Table 3).

Table 3: Supply chain integration features in three cases

Supply chain integration features	A	B	C
Internal integration (II)	√	√	√
Information is shared among all departments	√	√	√

Periodic inter-departmental meetings to review manufacturing planning	√	√	√
Synchronized data from purchasing, production, shipping, and sales	√	√	X
Cross-functional teams in problem-solving & process improvement	√	√	√
Cross-functional teams in new product development	X	X	X
Internal management communicates frequently about goals and priorities	√	√	√
Customer integration (CI)	√	√	√
Customer's (dealer) collaboration			
Information integration system	√	√	√
Computerized ordering & delivery system	√	√	X
Periodical meetings & Frequent communication	√	√	√
Active involvement in new product development (market research)	√	√	X
End-user satisfaction surveys	√	√	√
Sharing from major customers (dealers)			
Real-time searching of inventory & point of sales information	√	√	√
Demand forecast (sales plan)	√	√	√
Feedback on quality, design, and delivery performance	√	√	√
Updating market information, market trend	√	√	√
Sharing from manufacturers			
Production & delivery schedule	√	√	√
Marketing campaigns	√	√	√
Supplier Integration (SI)	√	√	X
Supplier's collaboration			
Information integration system & Computerized ordering system	√	√	
Strategic partnership (long-term relationship)	√	√	
Joint planning in production & purchasing (centralized purchasing)	√	√	
Suppliers' participation in the product design stage	X	X	
Just-in-time delivery	√	√	
Corporate-level communication/meetings	√	√	
Sharing from major suppliers			
Production schedule & capacity	√	√	
Available inventory	√	√	
Cost information (cost improvement)	√	√	
Sharing from manufacturers			
Production plan & real-time production schedule	√	√	
Demand forecast	√	√	
Real-time inventory data	√	√	
Cost information (centralized purchasing of materials)	√	√	
Performance (Quality-Cost-Delivery) standard	√	√	
Feedback to improve cost, quality, and delivery performance	√	√	

Process improvement supports to meet manufacturers' needs	√	√	

√: Yes X: No
The features are based on Zhao et al. (2011), Flynn et al. (2010), Braunscheidel and Suresh (2009)

In the interviews, all suppliers confirmed that they used MTO approach. Next, we visualize the SCI processes in terms of production planning in three dimensions at supply chains A, B, and C (Figures 3, 4, 5).

4.2. Why and how do firms implement specific SCI strategies?

Supply chain A's SCI processes

With big demand volume (Table 2) and low demand volatility, manufacturer A revealed they actively chose MTO and full SCI to ensure flexibility and maintained LSP big enough for efficiency. In Vietnam, Japanese manufacturers faced the severe problems of counterfeit parts and products. To protect their brand reputation and integrate information with dealers, Japanese manufacturers only distribute to their own exclusive dealers (Table 2). The information flows and coordination process are as follows.

Dealers sent four-week sales plans with full specifications of type and color via IT System before the 5th of month N-1 (Figure 3, LLSd1 = 25 days, LSPd =30 days). After that, dealers could send unexpected changes through email by the 15th of the month N-1 (Figure 3, LLSd2 =15 days, LSPd = 30 days). Since manufacturer A's production capacity was lower than the demand volume in 2018, dealers' sales plans are only for consideration. Manufacturer A notified the final allocated amount to dealers by the 25th of month N-1 (Figure 3).

In the maker dimension, the first production-sales meeting was held on the 8th. They fixed four-week production volume by model and two-week volume by full specifications (i.e., color) (Figure 3, LLSm=22 days, LSPm1 = 30 days by model, LSPm2 = 15 days by full specifications). They determined the first two-week production schedules and forecast for the remaining two weeks. Around the 23rd, they updated the dealers' plan changes, real-time inventory data, and sales trends. Based on that, they held a second meeting to determine the second two-week production schedule (Figure 3). Thus, they can adjust production schedule twice a month.

In the supplier dimension, suppliers started purchasing the long-lead time items (e.g., materials and import components) in month N-2 or N-3 to prepare for the production of month N based on manufacturer A's forecast (Figure 3). In month N-1, suppliers received fixed production schedules of four-week volumes by model and two-week volumes by full specifications around 15 days before production (Figure 3, LLSs=15 days, LSPs1 = 30 days by model, LSPs2 = 15 days by full specifications). Suppliers prepared manpower, materials, components, and production lines to make Just-in-time (JIT) delivery after receiving weekly actual orders.

Supply chain B's SCI processes

Manufacturer B faced higher demand volatility and had to pursue MTO with full SCI and small LLS and LSP to increase flexibility. In 2017, They used to use MTS and equally divide the monthly production to improve the stability in labor arrangement and production schedules. However, high inventory unfortunately accumulated at the end of that year, stocked from November 2017 until

March 2018. To respond to high demand volatility, they had to back to MTO from 2018. High demand volatility forced manufacturer B to use smaller LLP and LSP to adjust production schedule up to 4 times per month (Figure 4, Table 4). Dealers sent orders every two weeks by full specifications via the IT system (Figure 4, LLSd =15 days, LSPd = 15 days). In maker dimension, manufacturer B fixed a two-week volume by model and a one-week volume by full specifications after receiving dealers' orders (Figure 4, LLSm = 15 days, LSPm1 = 15 days by model, LSPm2 = 7 days by full specification). The second week was open to revision (i.e., color change) based on manufacturer B's review of inventories at factories and dealers. In the supplier dimension, suppliers received fixed two-week volumes of parts by models 15 days before production in month N-1 (Figure 4, LLSs1 = 15 days, LSPs1 = 15 days by models). One week before production, suppliers fixed a one-week volume by full specifications based on manufacturer B's weekly orders (Figure 4, LLSs2 = 7 days, LSPs2 = 7 days by full specifications).

Notably, besides production postponement, manufacturer B also applied delivery postponement. They divided orders into many small deliveries and delayed some if the inventory piled up at dealers. This helps to avoid product surpluses at dealer networks which cause the market price to fall.

In SCs A and B, MTO approach and the full SCI process is illustrated through the dashed line in Figures 3 & 4. According to interviews, due to low capability and management knowledge of Vietnamese dealers and suppliers in initial years, both manufacturers A and B have invested in supplier and dealer capability development programs besides the integrated IT system. These investments were huge but necessary to build trust and encourage SC partners for the information sharing and collaborations for coordinated processes.

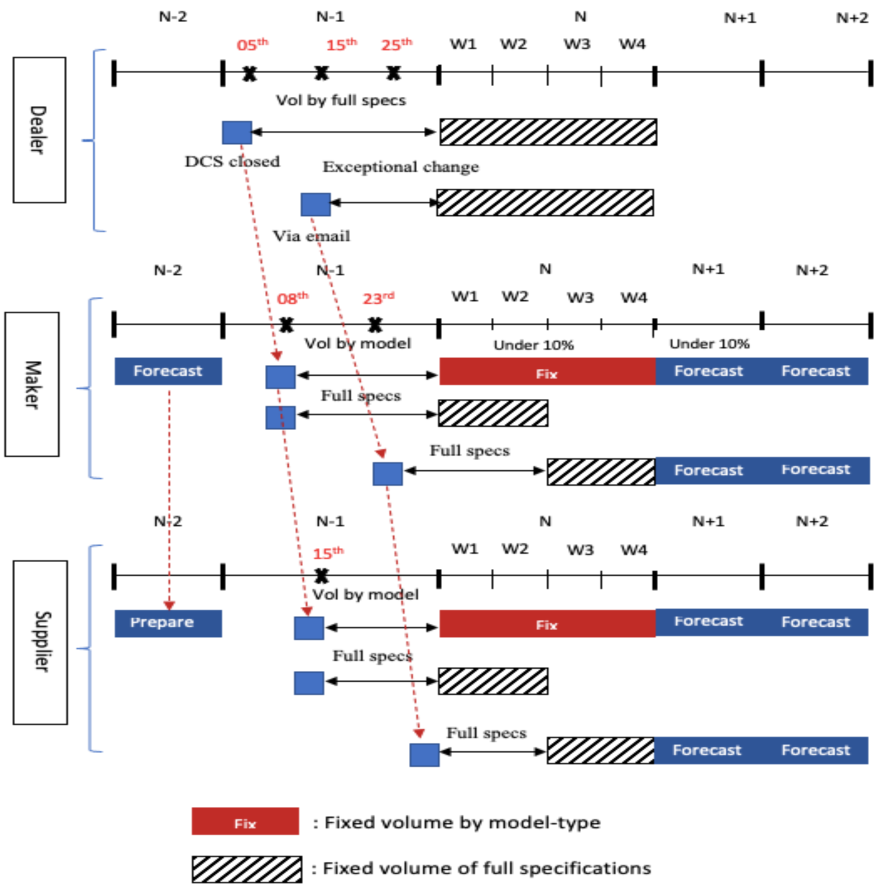


Figure 3: SCI process of manufacturer A in 2018

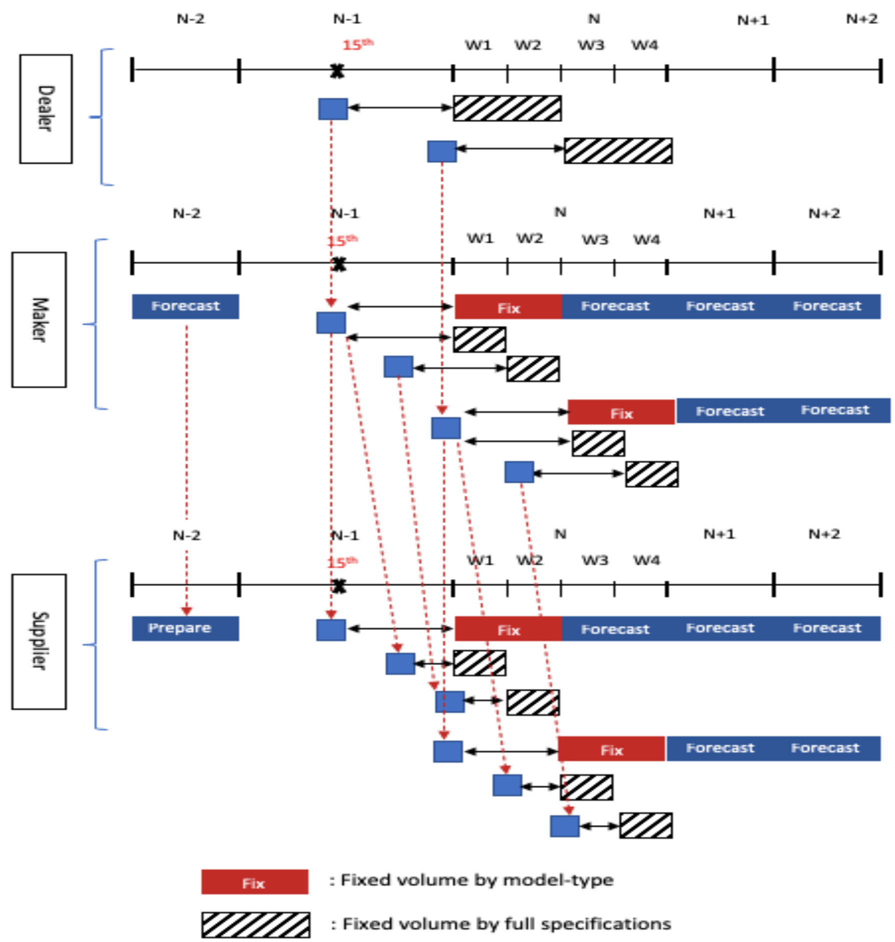


Figure 4: SCI process of manufacturer A in 2018

Supply chain C's SCI processes

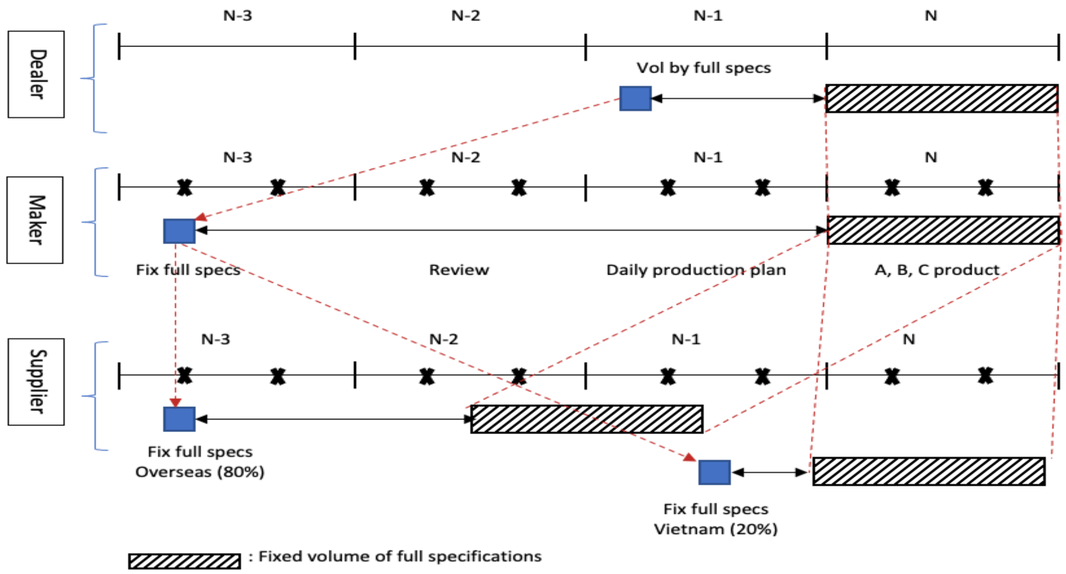


Figure 5: SCI process of manufacturer C in 2018

Manufacturer C revealed that due to very small demand volume (Table 2), it was unable to neither encourage their suppliers of core components to locate in Vietnam or ask Vietnam-based suppliers for investments in production lines dedicated to manufacturer C for JIT delivery. Since the core components suppliers were not located nearby and SI could not be conducted with overseas suppliers, the LLS and the time required to transport the components from overseas to Vietnam was longer (Figure 5, Table 4). Therefore, manufacturer C had no choice but to choose the ATO method to meet the required delivery lead times and avoid high stock of finished products. Manufacturing postponement was applied by stocking parts and only starting assembly after receiving dealers' orders. In this situation, manufacturer C utilized internal and customer integration to update market data and review the production plans (Table 3).

Around the 10th of month N-1, dealers sent four-week orders by full specifications via emails (Figure 5, LLSd=20 days, LSPd = 30 days by full specifications). Around the 10th of month N-3, manufacturer C fixed production volumes by full specifications for month N (Figure 5, LLSm =80 days, LSPm=30 days by full specifications). Every two weeks, manufacturer C held production meetings, considering dealers' feedback, to review the production plan. A daily assembly schedule was determined in month N-1. In 2018, manufacturer C produce sport bikes (80%) and scooters (20%). Orders of sport bike parts were sent to suppliers in Japan and ASEAN countries 3 months before production (Figure 5, LLSs1 > 30 days, LSPs= 30 days). Orders of scooter parts were sent to Japanese and Taiwanese suppliers located in Vietnam two weeks before production (Figure 5, LLSs2=15 days, LSPs= 30 days). While parts were delivered to the manufacturers within one day in supply chains A and B, it took about 45-60 days for manufacturer C to receive core parts from overseas suppliers after they finished all production orders.

4.3. Performance comparison

Table 4: CODP, SCI strategies & Performance Comparison

SCI	Level	A		B		C	
		LLS	**LSP**	**LLS**	**LSP**	**LLS**	**LSP**
Dealer	full spec	25; 15	30	15	15	20	30
Maker	Model	22	30	15	15	80	30
	full spec	22	15	15	7		
Supplier	Model	15	30	15	15	Local (20%): 15 Import (80%): >30	30
	full spec	15	15	7	7		
Delivery, CODP, SCI patterns							
Dd		55		30		50	
Pm		52		30		110	
Pm/Dd		0.95		1		2.2	
Method		MTO		MTO		ATO	
SCI strategies		Full SCI (CI, II, SI)		Full SCI (CI, II, SI)		II and CI	
Flexibility							
Dealers' orders (times/month)		2		2		1	
Makers' production planning (times/month)		2		4		1	
Inventory							
Maker's safety stock	Part	0		0		Local (20%): 1-2 days Import (80%): 7-14 days	
	Product	hourly		7-14 days		2-3 days	
Production efficiency							
Labor arrangement		stable		unstable		stable	
Bit time	moped	23 seconds		24 seconds		stop production	
	scooter	25 seconds		27 seconds		5 minutes	
	sport bike	NA		NA		6 minutes	

NA: not available information
Bit time: the time gap between two finished motorbikes in a production line
Unit of LLS, LSP, Pm, Dd: day

Dealers' required delivery lead times (Dd=LLSd+LSPd) and production lead times (Pm=LLSm+LSPm) are calculated in Table 4. Regarding delivery performance, all firms met Dd, which was 55, 30, and 50 days in supply chains A, B, and C, respectively. Pm/Dd ≤ 1 enabled the MTO at manufacturers A and B. Figures 3 and 4 demonstrate that SI helps to shorten Pm and become the enabler for MTO at manufacturers A and B. Meanwhile, manufacturer C could not make SI to shorten the whole supply lead times and had to adopt ATO. All manufacturers apply internal and customer integration to improve forecast accuracy (Tables 3&4).

Regarding flexibility, dealers of supply chains A and B could update their orders twice per month (Figures 3 & 4). Manufacturer B had the highest flexibility thanks to the small LLS and LSP with four production adjustments per month, which was followed by manufacturer A with two adjustments per month (Table 4). Meanwhile, supply chain C did not have these kinds of flexibility. These results demonstrate that manufacturers A and B with MTO and full SCI (CI, II, SI) had more flexibility than manufacturer C with ATO and II and CI alone (Table 4).

Then, we look at inventory. Manufacturers A and B had 0 inventory of parts (Table 4). Instead, manufacturer A asked their suppliers to typically keep three-day safety stock. Meanwhile, manufacturer C suffered from storing 7-14 days for imported parts for sport bikes (>80% of production) (Table 4). For the inventory of finished products, manufacturer A tried to supply to the dealers on an hourly basis. In contrast, manufacturer B kept 7–14 days of finished vehicles at factories (Table 4). Manufacturer B's relatively high safety stock of finished products even using MTO is because of the delivery postponement and high demand volatility mentioned above. Manufacturer C kept 2-3 days of finished products (Table 4). Since manufacturer C was holding many imported parts for assembly, they could reduce the safety stocks of finished products. In total, the inventory of both the parts and finished motorcycles at manufacturers was hourly at A, 7–14 days at B, and 10–19 days at C. These results illustrate that MTO firms with full SCI may control inventories better than ATO firms with only internal and customer integration.

Regarding production efficiency, manufacturers A and B applied process improvement and synchronous equipment in mass production to reduce the bit time by around 23–25 seconds, and 24–27 seconds, respectively (Table 4). Meanwhile, manufacturer C had a bit time of 5–6 minutes. Manufacturer C revealed no intention to speed up the bit time due to the small volume (Tables 2, 4). Besides, manufacturers A and C reported their efficient arrangement of labor while manufacturer B faced difficulties. Manufacturer A revealed that their demand volume was bigger than the supply capacity, and they faced very low demand volatility. Thanks to that, manufacturer A could limit the change rate within ±10 percent of yearly production plans to reduce the negative impact of change on its suppliers' production plans. Manufacturer C's stable demand volumes and customer integration facilitated high forecast accuracy. In contrast, manufacturer B reported that they faced high demand volatility, which resulted in unstable arrangements of labor. According to interviews with tier 1 suppliers, the instability in manufacturer B's production schedule also led to suppliers' production instability and inefficient labor arrangement. Thus, MTO combining with full SCI can mitigate the tradeoffs between efficiency and flexibility only under acceptable demand volatility associated with big demand volume (case A).

5. Discussion

In three Japanese motorcycle supply chains in Vietnam, all suppliers produce custom parts and choose the MTO approach, which is the upstream constraint. On the other hand, all manufacturers must meet the required delivery time, which is a downstream constraint. Under these constraints, we discussed why and how core firms use different configurations of CODP and SCI to achieve their organizational strategic objectives.

The results explicitly showcase that CODP positioning and SCI implementation are concurrent and interrelated processes. Therefore, they should be considered together, not separately. Importantly, the operational performance is different depending on configurations of CODP and SCI. Specifically, using full SCI (CI, II, SI) combined with MTO may lead to the high performance of delivery, flexibility, inventory control, and efficiency (case A, Table 4). However, the prerequisites are that (1) the demand volume is large, (2) demand volatility is relatively low, and (3) a rather long LLS and large LSP are acceptable (case A, Table 2, Table 4). When demand volume is relatively smaller and demand volatility relatively higher, short LLSs and small LSPs are needed to increase flexibility (case B, Table 4). In this case, the tradeoffs occur: core firms may have high performance of delivery, flexibility, and inventory control but face the instability of labor arrangement and production scheduling (case B). When demand volume is even smaller, it becomes impossible to locate suppliers in proximity or SI with remote suppliers. In this situation, combining ATO with CI and II is the only measure to mitigate the tradeoffs between efficiency and flexibility without threatening the delivery lead times required by the market. In this case, the manufacturer may face the problem of high inventory risk (Case C). Thus, we developed three propositions:

Proposition 1: CODP positioning and SCI implementation are concurrent and interrelated processes.

Proposition 2: The operational performance is different between configurations of CODP and SCI.

Proposition 3: Demand volume and demand volatility are the constraints on the feasible configurations of CODP and SCI.

We take a closer look at the unique nature of the supply chains where the core components are custom parts and suppliers must adopt MTO. The supply lead times consisting of suppliers' and manufacturer' lead times would be very long if manufacturers use MTO and their production only starts after suppliers finish all of production lots. Thus, supplier integration (SI), which allows suppliers and manufacturers to proceed and synchronize their production almost simultaneously, is important to reduce suppliers' lead times and satisfy downstream constraints. However, investments in supplier integration (SI) are costly. First, suppliers need to invest in manufacturer-specific production lines and manufacturers have to invest in initiatives to build trust for effective coordination. Second, the supplier's production line must be in proximity to facilitate JIT delivery to the manufacturer's assembly plant. The feasibility of these two investments is affected by the demand volume.

If the demand volume is large enough, the manufacturer can request SI to shorten the production lead time (Pm) by decomposing product specifications into coordinated processes with suppliers (Cases A and B). SI and JIT production can help shorten Pm so that $Pm/Dd<1$. Thanks to that manufacturers can choose MTO to increase flexibility under market uncertainty, especially in emerging markets.

When demand volume is small, manufacturers cannot achieve supplier integration (SI) (case C). If suppliers adopting MTO are not functionally integrated with the manufacturer, the overall Pm of the manufacturer will be lengthened because of the long delivery lead times of components. Moreover, suppliers without dedicated production lines do not give priority to production for manufacturer C, so manufacturers' orders must be sent early. Consequently, the manufacturer's production plan must also be finalized early, which prolongs the LLSm (Figure 5). Manufacturers' production lead times (Pm) becomes longer, so $Pm/Dd>1$. Thus, manufacturers have no choice but to use MTS or ATO to meet dealers' required delivery lead time (Dd). Thus, we have:

Proposition 4: In supply chains where the core components are custom parts, supplier integration is an enabler for MTO at manufacturers.

Proposition 5: Supplier integration is constrained by demand volume.

6. Conclusions

This study examined why and how firms implement specific SCI strategies using the multiple case study of the Japanese motorcycle SCs in Vietnam. This study provides various theoretical implications.

First, this study provides empirical evidence of (1) the concurrent and interrelated process of CODP and SCI strategy and (2) different operational performance depending on the configurations of CODP and SCI strategy. For the first time, the concurrent and interrelated process of CODP and SCI is explicitly examined, which contributes to the deeper understanding of SCI design and implementation. Based on findings, it is crucial to consider CODP location when examining SCI performance. Ignoring CODP location may be the main reason why prior studies have inconsistent results of SCI performance (Tarifa-Fernandez & De Burgos-Jiménez, 2017; Khanuja & Jain, 2019). MTS firms have less need for SI because their focus is on efficiency, not flexibility. In a study sample accidentally dominated by MTS and ATO firms, there is a risk of under-estimating the SI performance. In contrast, MTO firms have a greater need for SI because their focus is on flexibility. Therefore, in a study sample dominated by MTO firms, there is a risk of over-estimating the SI performance and assuming that it applies to all firms. Thus, researchers should assess operational performance based on the configurations of CODP and SCI strategy rather than based solely on SCI type. Generally, MTO combined with full SCI demonstrate superior performance.

Second, empirical evidence also shows that demand volume and demand volatility are the constraints on the feasible configurations of CODP and SCI. In the supply chains where the core components are custom parts, the prerequisite for MTO with full SCI at manufacturers is that demand volume must be big enough to encourage suppliers' investments in manufacturer-specific equipment for SI and JIT production. In other words, SI is an enabler for MTO at manufacturers while suppliers apply MTO; and SI is constrained by demand volume. When manufacturers can adopt MTO with full SCI, demand volatility then affects the level of SCI and performances. If demand volatility is low, manufacturers can utilize long LLS and large LSP to achieve both efficiency and flexibility. In contrast, if demand volatility is high, short LLSs and small LSPs are needed to increase flexibility but firms may face the production instability.

There are also managerial implications for managers. Evidence in this study shows that there is no optimal SCI practice for all cases. Firms should firstly define organizational objectives (i.e., flexibility or efficiency) based on their specific market characteristics (i.e., required delivery lead times, demand volume, and demand volatility). Based on that, they should select appropriate CODP location (i.e., MTO, MTS, or ATO) and SCI strategies. Under high market uncertainty, firms can increase flexibility and maintain certain efficiency by combing MTO and full SCI if their demand volume is big enough to enable SI.

The originality of this study is to provide the theoretical framework of SCI strategy selection and the visualization of SCI process involving dealers, manufacturers, and suppliers. Future studies can utilize the framework and visualization techniques to deeply analyze and compare the difference between firms' SCI strategies. Managers of firms also benefit from this framework to re-think and re-design their supply chain integration and coordination process according to demand changes.

This study also has their own limitations, which become the avenue for future research. This study deals with the supply chain where suppliers must adopt MTO due to custom part production. In supply chains where suppliers can adopt MTS, the constraints on CODP and SCI configurations may be alleviated for manufacturers. Future studies should further investigate the impact of suppliers' CODP location on manufacturers' choice of CODP and SCI configurations. Furthermore, this study does not discuss the configuration of MTS and SCI strategies. Case studies and survey research which include more diverse configurations of CODP location and SCI strategy are needed to complement to our findings.

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