Achieving Supply Chain Agility Through Product–Service Systems Offering

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Journal of Industrial Engineering and Management JIEM, 2024 – 17(2): 611-629 – Online ISSN: 2013-0953 – Print ISSN: 2013-8423 https://doi.org/10.3926/jiem.7521 Achieving Supply Chain Agility Through Product–Service Systems Offering Received: March 2024 Accepted: June 2024
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Abstract: Purpose: This paper aims to examine the role of collaboration, knowledge transfer, service partner development, information sharing and logistics integration on product–service systems supply chain agility. Design/methodology/approach: Data were collected from 405 official motorcycle service partners in Indonesia using questionnaires and were analyzed using structural equation modelling. Findings: Collaboration has a significant impact on knowledge transfer and information sharing. Information sharing and logistics integration as mediation to improve product–service systems supply chain agility. Likewise, knowledge transfers and service partner development also as mediation to enhance supply chain agility. As a result, collaboration has no significant direct impact to supply chain agility. Research limitations/implications: Given the state of the sampling refers to specific industry, so the generalization of the results will be limited. Practical implications: The model provides insight for managers on how collaboration, knowledge transfer, service partner development, information sharing and logistics integration positively affect product–service systems supply chain agility. Using measurement items of this study, managers can determine and evaluate the current state and formulate strategies to improve their product–service systems supply chain capabilities. Originality/value: The contribution of this study lies in investigating the role of dynamic capabilities for product–service systems offering to improve supply chain agility. This study provides benefits for academicians and industry by filling the gap of the nascent study in product–service systems and supply chain agility.
Keywords: supply chain agility, product–service systems, dynamic capabilities, collaboration To cite this article: Dewi, D. R. S., & Hermanto, Y. B. (2024). Achieving supply chain agility through product–service systems offering. Journal of Industrial Engineering and Management, 17(2), 611-629. https://doi.org/10.3926/jiem.7521
1. Introduction In recent decades, conventional manufacturing firms have grappled with significant challenges concerning their resources, including both personnel and materials. These challenges are so pressing that simply delivering a product is no longer sufficient; instead, there is a need to enhance the product's value within the context of business objectives (Bustinza, Vendrell-Herrero & Chiappetta-Jabbour, 2024). Among many solutions, an offering of product–service systems (PSS) as a bundle offering of product and service sound reassuring. PSS process is often called as part of effort as a servitization of the product manufacturing companies (Xing, Liu & Davies, 2023), and it refers to a novel business model innovation where a combination of product and service offerings acts as a driving force for innovation, aiming to create uniqueness and differentiation (Marcon, Marcon, Ayala, Frank, Story, Burton et al., 2022). Yet, the difficulty lies in how manufacturing companies will successfully provide their combined product and service packages to customers. Limited research has investigated how manufacturing companies compensate for their inadequate service capabilities through collaboration and partnerships. (Alzoubi, Elrehail, Hanaysha, Al-Gasaymeh & Al-Adaileh, 2022; Ayala, Paslauski, Ghezzi & Frank, 2017). Considering these needs, manufacturing companies ought to collaborate closely to ensure that services are delivered with enhanced value to customers (Ayala, Gaiardelli, Pezzotta, Le Dain & Frank, 2021). Long-term collaboration is especially essential for the value enhancement of PSS that prioritize offering bundled products and services rather than just products alone (Stegehuis, von Raesfeld & Nieuwenhuis, 2023). Primarily within the automotive industry, PSS has become indispensable for customers, largely due to their limited knowledge to independently conduct product maintenance. (Dewi, Hermanto, Pittayachawan & Tait, 2023). In the contemporary global business landscape, especially within the automotive sector, agility has emerged as a pivotal element for companies striving to gain a competitive edge (Basu, Abdulrahman & Yuvaraj, 2023). Agility refers to several characteristics: innovativeness, flexibility, speed and responsiveness (Al-Omoush, Palacios-Marqués & Ulrich, 2022; Kim & Chai, 2017; Shukor, Newaz, Rahman & Taha, 2021). Therefore, to achieve agility and provide Product-Service Systems, it is necessary to engage a network of stakeholders throughout the supply chain (SC). (Marcon et al., 2022). Collaboration among stakeholders along the SC is inherently complex in the Product-Service Systems process. Achieving successful collaboration necessitates the active participation of manufacturers to enhance supply chain capabilities and develop PSS SC

capabilities among all stakeholders in the supply chain network (Dewi, Hermanto, Sianto, Mulyana, Trihastuti & Gunawan, 2024; Dewi & Hermanto, 2023). To meet these needs, it is crucial for manufacturers to collaborate with actors in the SC network to ensure the delivering of PSS at the best value for customers (Al-Doori, 2019; Ayala, Gerstlberger & Frank, 2019). Close coordination among stakeholders in the supply chain network is essential for PSS to deliver enhanced value to customers. This focus entails providing a comprehensive package of both products and services, rather than solely the tangible product itself (Marcon et al., 2022). PSS are considered a component of the manufacturers duty to prolong the product life cycle. This involves collaborating with service providers responsible for maintaining the product and delivering associated services (Dewi & Hermanto, 2022). Therefore, manufacturers, being the strongest actor in the supply chain, typically offer their support by providing access to knowledge, fostering partner development, sharing technical expertise, and supplying other necessary resources required by the service suppliers (Ayala et al., 2019). To investigate the relationship with actors in the SC network, the Dynamic Capabilities (DC) is used as an underpinning theory. DC is utilized to understand how the SC capabilities of manufacturers can be transferred to service suppliers. It is well known that the firms that possess resources that are valuable, rare, not substitutable are difficult to imitate (Teece, 2007). However, the motivation to collaborate with external partners to provide PSS can outweigh the hurdle of sharing resources and capabilities (Story, Raddats, Burton, Zolkiewski & Baines, 2017). The cooperation of the process with service suppliers may involve logistics integration, information sharing, knowledge transfers and service supplier development. Few studies have investigated how the process of collaboration among manufacturers, intermediaries and service suppliers all together as SC networks closely collaborate to deliver PSS. For example, Story et al. (2017) confirmed that critical capabilities for multi actors in the SC to be able to deliver PSS are product–service innovation, customer focused, good synergy product-service and coordination product-service. They also highlighted that the provision of PSS can only be developed under collaboration and cooperation within the SC network. Further, Ayala et al. (2019) demonstrated that the support and collaboration from service suppliers is paramount as the PSS is completely delegated to the service suppliers. Therefore, building knowledge and partner development are crucial to manage the service suppliers' capabilities. They found that offering, knowledge related to PSS and joint PSS development positively affect PSS delivery. However, little is known about the link among PSS SC capabilities required such as collaboration, knowledge transfer, service supplier development, logistic integration and information sharing to become agile. A quantitative survey of 405 motorcycle service suppliers in the Indonesian motorcycle industry was collected. Our results confirm that collaboration has a positive impact on knowledge transfer and information sharing, while knowledge transfer, service partner development and information sharing, logistics integration function as mediation to improve supply chain agility. 2. Theoretical Background and Hypotheses Development In this section, a theoretical framework is built to confirm the relationship between collaboration, transfer knowledge, service partner development, information sharing, logistic integration and supply chain agility, accompanied with the hypothesis relating their relationships. 2.1. Literature Review of PSS Our literature review in PSS has shown adoption of PSS within organizations, using the business model canvas as a framework. The business model canvas has been utilized by researchers like Adrodegari, Saccani, Kowalkowski and Vilo (2017), Kindström and Kowalkowski (2014) and Salwin, Jacyna-Goł da, Kraslawski and Waszkiewicz (2022) to identify various capabilities necessary for PSS namely customer segments, customer relationships, distribution channels, revenue stream, key resources, key activities, key partners, value proposition, and cost structures. Several empirical studies of PSS used a qualitative case study method. These studies identified the different factors that impact the PSS delivery (Parida, Sjödin, Wincent & Kohtamäki, 2014) investigated the distinctive capabilities related to PSS delivery in Swedish and Finnish manufacturing companies. This study revealed four critical capabilities: network management, service delivery network management, and integrated development for service and product–service value offerings. Reim, Sjödin and Parida (2019) investigated the capabilities needed to adopt a PSS and identified service extensión, service benchmarking, digitalization to support PSS and customer creation. Resource-based theory, encompassing concepts like the resource-based view (RBV) and dynamic capabilities, has been the primary theory applied in both the PSS and SC fields (Ayala et al., 2019). RBV stands out as a leading strategy for enhancing an organizations resources and capabilities to gain competitive advantage (Madhani, 2010). It emphasizes leveraging existing organizational resources to sustain performance by capitalizing on internal strengths, addressing weaknesses, and mitigating external threats (Priem & Butler, 2001). Wallin, Parida and Isaksson (2015) conducted a three-year study on an aerospace company to examine the progression of its adoption of PSS. The research unveiled the operational capabilities utilized throughout this process, such as fostering a PSS-friendly environment, facilitating networking collaborations, engaging in cooperation with external partners, encouraging internal partnerships, and developing expertise in PSS. However, RBV static nature renders it inadequate for coping with the rapid fluctuations in competitive markets, resulting in diminishing resource advantages over time (Teece, 2007). Dynamic Capabilities (DC) assists organizations' capabilities to quickly respond to the erratic changes in environment by sensing, seizing and reconfiguring internal and external resources and capabilities through the improvement of the micro foundation (Pitelis, Teece & Yang, 2023). Sensing is the capability of understanding the internal and external threat by observing the surrounding environment (Teece, 2007). Seizing is the next capabilities required to pursue the opportunity (Teece, 2007). Then finally, reconfiguring is needed for the possibilities of chasing the opportunity through the offering of PSS (Teece, 2007). DC fits well with the idea of cooperation and build capabilities within SC network (Siems, Land & Seuring, 2021). Therefore, DC is ideal as underpinning theory in this study as it is consistent with the supply chain and PSS concept. The supply chain capabilities required for PSS offering are quite challenging to be developed alone (Dewi et al., 2023; Trihastuti, Dewi, Santosa & Yuliawati, 2024). They need to be enhanced in the network supporting by the interaction stakeholders in the SC, such as: manufacturers, intermediaries, suppliers and service partners (Beske, Land & Seuring, 2014). Ayala et al. (2019) introduced a model incorporating four DC aimed at maximizing the benefits of PSS. Their research highlighted the significance of PSS offerings, resources, and activities, with service supplier development exhibiting different behaviors based on whether the PSS was product-oriented or results-oriented. Ayala et al. (2017) also underscored the importance of knowledge sharing among supply chain partners. Raddats, Zolkiewski, Story, Burton, Baines and Ziaee-Bigdeli (2017) outlined four capabilities essential for manufacturers in collaborative settings: knowledge development, PSS enablement, PSS development, and risk management. Story et al. (2017) proposed six DC for delivering PSS, emphasizing aspects like innovation, interaction processes, actor, business culture evolution, working with other actors and infrastructure development. The current research focuses on how manufacturers balance innovation in both products and services while maintaining effective collaboration with service partners, primarily prioritizing customer-centric perspectives. Methods Theory Capabilities References Qualitative Business Model Canvas Customer segments, customer relationships, distribution channels, revenue stream, key resources, key activities, key partners, value proposition, and cost structures Adrodegari & Saccani, 2017; Salwin et al., 2022; Kindström & Kowalkowski, 2014 Qualitative - Network management, service delivery network management, integrated development for service, and PSS offering Parida et al., 2014 Qualitative - Value proposition, customer segmentation, PSS elements, network partners and value creation Reim et al., 2019 Qualitative RBV PSS-friendly environment, facilitating networking collaborations, engaging in cooperation with external partners, encouraging internal partnerships, and developing expertise in PSS Wallin et al., 2015 Quantitative DC PSS offering, resource, activity, service supplier development Ayala et al., 2019 Qualitative DC Knowledge development, PSS enablement, PSS development and risk management Story et al., 2017 Qualitative DC Innovation, interaction processes, actor, business culture evolution, working with other actors and infrastructure development Story et al., 2017 Qualitative DC Knowledge development, external collaboration with external partners Paiola, Khvatova, Schiavone & Jabeen, 2022 Quantitative Organizational processing theory information processing capability and data integration with customers and suppliers Dalenogare et al., 2022 Qualitative - External environmental factors, internal firm factors, capabilities, business models and processes, and value creation and interaction Burton et al., 2024 Table 1. The summary of the PSS literature review Recently, research on PSS has shifted towards digitalization, for example, Rapaccini, Paiola, Cinquini and Giannetti (2023) confirmed that Knowledge-intensive business services firms have the capacity to serve as origins, facilitators, and conveyors of knowledge. Additionally, SC should collaborate with external partners to contribute to the transfer and development of knowledge. On the contrary, Burton, Story, Zolkiewski and Nisha (2024) employed the capability paradox, which describes the obstacles towards the digitalization of PSS, namely external environmental factors, internal firm factors, capabilities, business models and processes, and value creation and interaction. Further, (Dalenogare, Le Dain, Benitez, Ayala & Frank, 2022) found that information processing capability and data integration with customers and suppliers improve PSS. The summary of the PSS literature review is presented in the Table 1. These studies primarily aimed at developing a model for PSS. However, they often neglected to address how capabilities were transferred to other stakeholders within the SC network. Most studies on PSS have primarily concentrated on the downstream supply chain, even those recently research that focusing on digital development, predominant focus on customer service. Looking at the existing research gap in PSS, to gain a broader perspective and competitive advantage, an integrated approach that incorporates supply chain management concepts, particularly emphasizing agile delivery of PSS, is essential. Our conceptual framework is built on prior research from PSS literature review, dynamic capability literature review and supply chain management concept. From the perspective of supply chain management, Negi (2024), Panahifar, Byrne, Salam and Heavey (2018) and Pham, Nguyen, Mcdonald and Tran-Kieu (2019) found that there were key capabilities crucial for attaining competitive performance, which include long-term collaboration, logistics integration, and information sharing. Collaboration within the supply chain is fundamental to any partnership and cooperation. Particularly in the motorcycle industry, long-term collaboration is favored over short-term cooperation due to the need for sustained network development and dynamic capabilities formation, which necessitate prolonged cooperation to align with the supply chains objectives. In light of the changing business environment, integrating aspects of supply chain management concepts, dynamic capabilities and Product-Service Systems is essential, as well as understanding their interconnectedness to enhance supply chain agility. The aim of this paper is to investigate the relationship of collaboration, knowledge transfer, service partner development, information sharing and logistics integration and supply chain agility. Drawing from the theoretical background outlined in this section, we can construct the conceptual framework of this paper. the following subsections elaborate on the detailed hypotheses regarding the relationships within the research model. 2.2. Logistics Integration and Supply Chain Agility In this section, we focus on logistic integration which is defined as effectively well coordination and smooth flow of product and information (Danese, Molinaro & Romano, 2020). To investigate the relationship between logistic integration and supply chain agility, DC is used as an underpinning theory. DC has been commonly utilized to examine the companys capability to constantly rebuild, integrate, renew its crucial capability and resources to respond to rapid changing environment (Helfat, Finkelstein, Mitchell, Peteraf, Singh, Teece et al., 2009). DC should be noted as difficult to be developed alone as they should be enhanced together within supply chain network (Pitelis et al., 2023). Therefore, dynamic capabilities can elucidate how collaboration among companies can result in improved agility performance. The unique resources possessed by each firm, which are rare, difficult to replicate, valuable, and irreplaceable, cannot be easily replicated by another firm. However, under a collaborative framework, a firms performance is influenced not only by its internal resources but also by the external resources within the supply chain network (Teece, 2023). Logistic integration involves seamless and coordinated logistic activities such as flow of product and information (Jafari, Eslami & Paulraj, 2022). Such collaboration impacts on a transparent connection among stakeholders in the SC (Alzoubi et al., 2022). Logistic integration brings many benefits to the performance of stakeholders in the SC (manufacturers, intermediaries and service partners), such as improving product quality, operational efficiency and response to the customers (Alzoubi et al., 2022). A number of studies have reported the positive link between logistic integrations and performance (Turabi, 2024). Danese et al. (2020) also reported that the higher degree of supply chain integration impact to higher degree of supply chain performance. SC agility is defined as the firms' capability to experience and rapidly react to market's unpredictability (Gligor, Stank, Gligor, Ogden, Nowicki, Farris et al., 2023). Agility is pointed out to several characteristics: flexibility, responsiveness, adaptability, innovativeness and speed to achieve competitive advantage (Kim & Chai, 2017). Gligor, Gligor, Holcomb and Bozkurt (2019) and Al-Omoush et al. (2022) characterized SC agility as speed, responsiveness, flexibility and innovativeness. This study acquires these four characteristics to measure SC agility. Several characters of supply chain performance overlap with the SC agility. Hence, we hypothesized as follows: H1. Logistic integration has a positive relationship with supply chain agility. 2.3. Service Partner Development and Supply Chain Agility Service partner development refers to dynamic capabilities aimed at enhancing the capabilities of partners, involving processes designed to achieve supply chain goals through experimentation and training programs. (Encinas-Bartos, Schwarzkopf & Mueller, 2024). As manufacturing companies endeavor to provide PSS, which prioritize services alongside products, the development of service partners becomes a critical step. This transformation of the supply chain paradigm involves seamlessly integrating service partners into the process (Jia, Stevenson & Hendry, 2023). Yawar and Seuring (2018, 2020) confirmed that the higher level of collaboration and integration processes lead to better supply chain performance. In line with previous studies, we argue that service partner development enables the supply chain to achieve its agility. For example, Benton, Prahinski and Fan (2020) emphasized that to remain competitive, a company must enhance its partners' capabilities to achieve the goals of the supply chain by sharing its own capabilities. Teece (2007) identified three dynamic capabilities: sensing, seizing and reconfiguring. The sensing capability requires a process to gather data, interpreting information and allocating resources (Pitelis et al., 2023). Seizing includes the activity of identifying the opportunities and threat (Engelmann, no date). It helps companies to make a decision making procedure. Reconfiguring involves the continuous effort to cope with rapid changes in the environment (Engelmann, 2023), and requires strategic actions to build a rigor dynamic capabilities with service partners. The achievement of supply chain goals necessitates the development of capabilities among all stakeholders involved, including the weakest partners. Manufacturers, despite possessing product knowledge, cannot solely provide PSS on their own (Ayala et al., 2021). Alternatively, they require service partners to handle the service aspect. Therefore, service partner development plays a crucial role in supporting a network of service partners by offering diverse training programs focused on product knowledge and technical expertise in product maintenance (Encinas-Bartos et al., 2024). Coşkun, Kumru and Kan (2022) and Paybarjay, Fallah-Lajimi and Hashemkhani-Zolfani (2023) noted that partner development could increase supply chain performance. Based on the above arguments, the following hypothesis is developed: H2: Service partner development has a positive relationship with supply chain agility. 2.4. Knowledge Transfer and Service Partner Development Knowledge transfer is defined as the capability to understand, access and share the valuable resources and knowledge (Zaid, Sleimi, Saleh & Othman, 2023). In this study, it is important to acknowledge DC as a foundational theory, particularly highlighting the functions of sensing, seizing, and reconfiguring in knowledge transfer. These three capabilities entail establishing long-term collaborations as enduring partners (sensing), exploring new knowledge and connecting it to stakeholders in the supply chain (seizing), and consistently evaluating knowledge transfer capabilities by modifying, discarding, or adding knowledge suitable to the supply chain (reconfiguring). (Kindström, Kowalkowski & Sandberg, 2013). Knowledge is considered as one of the most paramount capability to stay in the competition, thus there is increasing interest in understanding on how effective knowledge transfer among stakeholders in the SC (Eslami, Achtenhagen, Bertsch & Lehmann, 2023). Following this argument, the knowledge transfer within the SC network is a way to access and share knowledge and valuable resources among stakeholders in the SC (Li, 2021). It is proven that the success from competition cannot be achieved by the solitaire firm itself but often embedded in the capabilities of all stakeholders in the SC (Marcon et al., 2022). Hence, the continuous exchange of knowledge within the SC network can be seen as a fruit of sustainable collaboration to improve their dynamic capabilities (Kindström et al., 2013). In the provision of Product-Service Systems, service partners hold a critical role, especially within knowledge-intensive sectors like automotive. Ensuring that service partners can readily access the necessary knowledge for PSS delivery is imperative (Dewi et al., 2023). Moreover, there is substantial evidence confirming that supplier development serves as a method for companies to collaborate and enhance the performance of their suppliers, thus ensuring competitiveness (Saghiri & Wilding, 2021). The service partner development program serves as a mechanism for knowledge transfer. By intensifying training through supplier programs, employees of service partners can enhance their knowledge and skills (Encinas-Bartos et al., 2024). Consequently, the enhanced skills and knowledge of the service partner will reflect in an improvement in the performance of the service partner (Jia et al., 2023). Hence, the above arguments support the following hypothesis to the study: H3: Knowledge transfer has a positive relationship with service partner development. 2.5. Information Sharing and Logistic Integration Information sharing refers to activities of exchanging crucial information among stakeholders in the SC (Tang, Chau, Ip & Ji, 2023). The benefits of information sharing include enhancing the quality of information and information processing capability which obviously reduces the uncertainty and trust issue in collaboration (Ahmed, Khan, Najmi & Khan, 2023). For example, Bai, Govindan and Huo (2023) verified that through information sharing, all stakeholders within the supply chain can access real-time information from their counterparts, thereby reducing the bullwhip effect and enhancing both firm and supply chain performance. The readiness to share information necessitates companies exchanging strategic information within the supply chain network (Yang, Huo & Gu, 2022). Access to real-time inventory levels and demand requirements from supply chain partners enables partners to improve replenishment planning, indirectly enhancing their firms performance (Kim & Chai, 2017). The activity of information sharing and logistics integrations requires the partnership and cooperation among stakeholders in the SC (Bai, 2024; Bai et al., 2023). Thus, these two capabilities fit a dynamic capabilities approach that emphasize sensing, seizing and reconfiguring to achieve a high level of performance. Furthermore, a number of studies have exemplified a variety of logistics integration advantages from the power of information sharing such as lowering the inventory level and bullwhip effect (Tang, Yang, Tu & Ma, 2021). Hence, the above arguments support the following hypothesis to the study: H4: Information sharing has a positive relationship with logistics integration. 2.6. Collaboration and Knowledge Transfer, Information Sharing, Supply Chain Agility Collaboration is defined as two or more companies form long-term relationships to achieve one goal by sharing information, capabilities and resources (Ralston, Keller & Grawe, 2020; Ruiz-Alba, Soares & Rodrguez Molina, 2023). This study focuses on PSS delivery by multi actors in the SC so that the collaboration among stakeholders in the SC is paramount. However, forming dynamic collaboration capabilities is not unchallenging. Underlying the value from DC, collaboration capability is valuable and hard to replicate. Several studies demonstrated that SC collaboration characterized by sharing resources, jointly planning, has many different channels to communicate and have agreement goals, has strong collaborative possibilities (Ralston et al., 2020; Zhang & Cao, 2018). SC collaboration heavily dependent on sharing resources and trust, focuses on collaborative effort to be able to offer customer-oriented PSS delivery (Marcon et al., 2022). Previous studies found that collaborations allow firms to access to knowledge and information required leading to improve companies' performance (Ralston et al., 2020; Ruiz-Alba et al., 2023). Effective collaboration leads to a better level of transfer knowledge and information sharing (Kim & Chai, 2017). Collaboration is often seen as a way to seize business strategy within the SC network. For example, DC were utilized to promote cooperation among many actors within the SC network to enhance transparency of information sharing, technology sharing and accessibility of knowledge (Cao, Vonderembse, Zhang & Ragu-Nathan, 2010; Zhang & Cao, 2018). Likewise, collaboration is frequently seen as crucial element to supply chain agility (Dubey, Bryde, Foropon, Tiwari, Dwivedi & Schiffling, 2021). Hence, the above arguments support the following three related hypotheses: H5: Collaboration has a positive relationship with knowledge transfer. H6: Collaboration has a positive relationship with information sharing. H7: Collaboration has a positive relationship with supply chain agility. 3. Research Methods 3.1. Development of Instrument A questionnaire was developed based on a literature review conducted in section 2. Items of measurement consisted questions measuring six domain constructs: collaboration (C) is 7 items, knowledge transfer (KT) is 5 items, supplier partner development (SPD) is 5 items, information sharing (IS) is 5 items, logistics integration (LI) is 5 items and supply chain agility (SCA) is 7 items, with five-point likert scale from strongly disagree to strongly agree (Table 2). To provide validation of the preliminary stage, four academic experts in PSS and supply chain were enlisted to deliver feedback on questionnaire consistency, logical, clarity and relevance. Then an interrater agreement survey with 30 head of service partner suppliers was participated. Three criteria recommended for dropping ítems: (1) drop items when its mean value is less than the midpoint, (2) drop items left from (1) when $p > 0.05$ and (3) drop items left from (2) when power < 0.8. As a result, there is no items deleted so that 34 items were persisted for the questionnaire. Code Domain of Construct and Items References Factor loading Collaboration (C) is defined as a partnership activity of creating new resources where two or more parties jointly work together to achieve mutual benefit C1 We sense and seize a long-term collaborative relationship with our main dealer partner based on mutual trust Zhang & Cao, 2018 0.823 C2 We work jointly on the PSS planning with our main dealer partner Zhang & Cao, 2018 0.817 C3 We collaborate with our main dealer partner to reconfigure PSS offering Dubey et al., 2021 0.752 C4 We collaborate with our main dealer partner to identify and understand the customers' need Dewi et al., 2023 0.796 C5 We have many different channels to communicate Zhang & Cao, 2018 0.825 C6 We have agreement on the same SC agility readiness goals (deleted) Al-Omoush et al., 2022 - C7 We exchange knowledge and relevant information (deleted) Zhang & Cao, 2018 - Knowledge transfer (KT) is defined as the capability to transfer and access knowledge among stakeholders in the SC KT1 Our main dealer partner transfers its knowledge of PSS to us Ayala et al., 2017 0.856 KT2 Our main dealer partner shares its knowledge about the benefit of being agile as our goal Al-Omoush et al., 2022 0.842 KT3 We receive knowledge about information technology that we use to deliver PSS Dewi et al., 2023 0.844 KT4 Our main dealer partner continuously supports us to share about our customers' expectations Dewi et al., 2023 0.807 KT5 Our main dealer partner constantly transfers knowledge of innovations for a bundle of product and service Ayala et al., 2017 0.840 Service partner development (SPD) is defined capability to develop partner capacity by providing variety of training and reconfigure overall performance within SC SPD1 Our main dealer partner has ceaselessly upgrades our knowledge (deleted) Dewi et al., 2023 - SPD2 Several training courses has been prepared to us to increase our speed, flexibility, responsiveness and innovativeness Dewi et al., 2023 0.872 SPD3 A service partner development programs has been provided by our main dealer partner Ayala et al., 2019 0.843 SPD4 Our main dealer partner strengthens our capabilities to achieve supply chain agility Ayala et al., 2019 0.808 Code Domain of Construct and Items References Factor loading SPD5 Variety training courses of product and technical service has Paiola, Saccani, Perona been supplied to us & Gebauer, 2013; Rapaccini et al., 2023 0.814 Information sharing (IS) s defined as capability to sense and seize SC information for any stakeholders in the SC IS1 We share delicate information to our service partner Lambourdiere & Corbin, 2020 0.797 IS2 Our main dealer partner are transparent to share any information Bai et al., 2023 0.733 IS3 Information interchange is continuing and repeatedly Kim & Chai, 2017 0.843 IS4 Our main dealer partner continuously update us with recent information Kim & Chai, 2017 0.804 IS5 Our main dealer partner keep frequent meeting and communication (deleted) Kim & Chai, 2017 - Logistics integration (LI) Is defined as the capability to integrate logistics activities to create overall values to customers LI1 Our supply chain logistic activities are strictly collaborated Chen & Paulraj, 2004 0.739 LI2 Our main dealer partner logistics routines are effectively coordinated with ours Chen & Paulraj, 2004 0.725 LI3 We have a smooth coordination of logistics activities with our main dealer partner Chen & Paulraj, 2004 0.853 LI4 Our logistics coordination is specified by outstanding warehouse facilities and distribution Chen & Paulraj, 2004 0.842 LI5 The incoming and outgoing coordination of product distribution is completely harmonize (deleted) Chen & Paulraj, 2004 - Supply chain agility (SCA) as the SC capability to quickly adopt to fluctuating, erratic and unstable working environment SCA1 We always quickly improve our PSS level of customer satisfaction Kim & Chai, 2017 0.810 SCA2 We always quickly improve our PSS delivery reliability Kim & Chai, 2017 0.842 SCA3 We always quickly reconfigure PSS SC capabilities to adopt with changing market needs Kim & Chai, 2017 0.824 SCA4 We always quickly reconfigure SC resource capacity to Boon-itt, Wong & respond to uncertain demand Wong, 2017 0.833 SCA5 We always quickly adapt PSS SC operation to decrease service lead time Al-Omoush et al., 2022 0.873 SCA6 We always quickly reconfigure our capabilities to customize customer order Shukor et al., 2021 0.657 SCA7 We always quickly innovate our PSS offerings new 0.788 Table 2. Theoretical domain of constructs and items 3.2. Data Collection and Sampling The data from this study were collected from the Indonesian motorcycle service partner from December 2022 to June 2023. The list of participants was randomly chosen from sampling frame of 8450 service partner from five motorcycle brands, with the criteria that the head of service has working experience for at least twelve months. In total, nine hundred fifty questionnaires were distributed, the response came back with 405 questionnaires (42.6 % response rate). The data has been checked for non-response bias. The Levene's test for equality of variance and a t-test equality of means performed the early and late wave were not statistically significant. The demographics profile of the participants are as follows: the participants are mostly males (95.8%) with the education of senior high school or higher with almost 99.3%. The service partners can be identified as small companies with employees less than 10 (89.6%) and originated mostly from Java island (70.6%), also have more than 10 years' collaboration with their brands (67.2%). This is because Java known as a the most populated island in Indonesia. Likewise, the motorcycle brand in Indonesia is dominated by one brand who became the majority participants in this research (72.6%). 4. Result 4.1. Construct Validity and Reliability Confirmatory factor analysis (CFA) was needed to examine the validity of all variables utilized in this study using AMOS (version 26). The results of CFA and factor loadings are presented in Table 1. Using Structural Equation Modelling (SEM) requires several Goodness of Fit (GOF) indices to assess fit between the observed covariance matrix and the hypothesized model. Hu and Bentler (1998) and Yu (2002) introduced the cut off value of GOF as guidance $p > 0.01$, norm $\chi 2 \leq 2$, RMSEA < 0.05, SRMR < 0.07, CFI > 0.96 and TLI > 0.95. Using this guidance resulted several items to be deleted from the model: C6, C7, SPD1, IS5 and LI5. The overall model fit and standard items loading indicated the evidence of convergent validity (Hair, Black, Babin, Anderson & Tatham, 2010). Then, the values of Cronbach's alpha are between 0.871 and 0.928 to confirm the scale reliability of the six constructs (Hair et al., 2010). 4.2. Discriminant Validity Discriminant validity aims to ensure that the construct has powerful relationships with its constructs (Hair et al., 2010). Discriminant validity among the six constructs are attained by the value of average variance extract (AVE) for each construct is bigger than the value of the square correlation between the corresponding construct (Table 3). IS CO KA PD LI SCA IS 0.795 CO 0.392 0.802 KA 0.385 0.759 0.838 PD 0.373 0.705 0.777 0.834 LI 0.634 0.474 0.454 0.513 0.794 SCA 0.508 0.315 0.336 0.433 0.680 0.806 Table 3. AVE and square inter-construct correlation value 4.3. Common Method Bias We utilized Harman's single-factor test to investigate the Common Method Variance (CMV) (Podsakoff, MacKenzie, Lee & Podsakoff, 2003), all items in the constructs were placed to one factor, using maximum likelihood extraction revealed AVE of 35% showed no CMV exists. Further examination of CMV, a common latent factor (CLF) was added up the measurement model (MacKenzie, Podsakoff & Podsakoff, 2011). By adding CLF to all observed items in the CFA model, the result revealed that the regression weights value deviation of CFA model without and with CLF were smaller than 0.2, indicating that CMV was not present. 4.4. Assessment of Structural Model and Result of Hypotheses The result of the proposed structural model is presented in Figure 1, the model produced a good fit model with normed $\chi 2= 1.67$; SRMR=0.04; RMSEA=0.04; CFI=0.97; TLI=0.97. The Bollen-Stine bootstrapping with 2000 random bootstrap samples produced a p-value of 0.06 which guarantees the fit of the structural model. The parsimonious of the model is guaranteed with PCFI value of 0.88. The six hypotheses were investigated using SEM technique. The result exhibit that logistics integration has a positive relationship with supply chain agility (0.654 at $p < 0.001$), supporting H1. Hypothesis H2 of service partner development on supply chain agility is supported by path coefficient 0.210 at $p < 0.002$. Likewise, H3 is supported by evidence that knowledge transfer has a positive relationship with service partner development (0.791 at $p < 0.001$). Furthermore, H4 is supported as shown that information sharing has a positive relationship with logistics integration (0.660 at $p < 0.001$). Collaboration has a positive relationship with knowledge transfer as postulated in H5 (0.779 at $p < 0.001$). H6 is the result indicates that collaboration has a positive relationship with information sharing (0.434 at $p < 0.001$). Finally, H7 shows that collaboration has no direct significant impact to supply chain agility. The values of R2 for knowledge transfer, information sharing, service partner development, logistics integration and supply chain agility are 0.61, 0.19, 0.63, 0.43. 0.47. Figure 1. Result of the structural model 5. Discussion This study contributes to scarce literature on PSS and supply chain management (SCM) concept by integrating the concept of supply chain for PSS offering underpinning by DC. This study plays a part in existing PSS and SCM literature by developing six capabilities: collaboration, knowledge transfer, service partner development, information sharing and logistic integration to improve SC agility. Pointedly, this study promotes to the PSS, SCM and DC with following respects. First, this study highlights the collaboration guide foster cooperation behaviors including transfer knowledge and information sharing, as to the positive relationship findings demonstrated by hypothesis 5 (H5) and hypothesis 6 (H6), respectively. For example, knowledge transfer and information sharing cannot be attained before collaboration is formalized. The threat of sharing crucial information and important knowledge can be refrained from if only the firms have strategic long term cooperation and collaboration. DC as an underpinning theory in this study, facilitate the understanding of the SC to be able to cooperate, collaborate, integrate, acquire and reconfigure resources and capabilities within SC. Ramjaun, Rodrigues, and Kumar (2024) and Dubey et al. (2021) confirmed that collaboration is primarily serve as a function of integration within SC stakeholders. Further, the finding in this study is consistent with Wang and Hu (2020) who confirmed that the level of transfer knowledge has influenced by the level of strategic cooperation among SC stakeholders. The finding in this study also agree with Panahifar et al. (2018) that showed information sharing heavily impacted from the fruit of the long-term collaboration among stakeholders in the SC. The long-term collaboration indicates stakeholders within SC have enhanced mutual trust leading to mutual benefits and goals. Second, this study demonstrates that service partner development required to be preceded by the transfer knowledge. By means of this, service partner development will be clearly guided by knowledge transfer, certainly the knowledge transfer has substantial positive impact on service partner development, as demonstrated by hypothesis 3 (H3). This finding is consistent with previous research of Beske et al. (2014) that knowledge transfer can be transferred through supplier development program. Likewise, Evers and Purwaningrum (2013) found that flow of transfer knowledge to the other partners is mediated by the partner development. Third, this study demonstrates that information sharing has significant positive impact towards logistics integration, as demonstrated by hypothesis 4 (H4). The benefits of information sharing include enhancing the quality of information and information processing for all stakeholders in the SC so that significantly helps firms to handle with uncertainty and minimize the bullwhip effect. This obviously will increase the certainty to make logistics decisions. The finding of this study is consistent of previous study of Sundram, Chhetri and Bahrin (2020) that through information sharing have been considerably beneficial to many logistics activities. Fourth, this study demonstrates the direct link of collaboration to supply chain agility is not significant, as demonstrated by hypothesis 7 (H7). It means that the relationship of collaboration to supply chain agility is fully mediated by knowledge transfer, service partner development and information sharing, logistics integration. Collaboration is as base of any alignment in the SC such as knowledge transfer, service partner development, information sharing and logistics integration. For example, coordination among stakeholders in the SC includes sharing key information. Logistics integration is also a form of close collaboration within the SC as some critical information such as production plan, demand forecast and inventory level are shared in the SC. As a result of this close collaboration, this study marks that there is positive impact of service partner development, as demonstrated by hypothesis 2 (H2) and logistics integration to supply chain agility, as demonstrated by hypothesis 1 (H1). The numerical results regarding collaboration identify five items with substantial factor loadings: long-term collaborative relationships, jointly PSS planning, collaborate to reconfigure PSS, understand customers' need and has many different channels to communicate. Further the findings on knowledge transfer list five items with high factor loadings: transfer knowledge from main dealers to service partners, share knowledge about being agile, knowledge of information technology, share of customers' expectations and constantly transfer knowledge of PSS. Next, the findings on service partner development recognize four significant factor loadings: several training courses have been prepared, availability of service partner development programs, strengthen capabilities to improve agility and variety training courses for PSS. Information sharing confirm four high factor loadings: share delicate information, transparent to share information, information interchange is continuing, continuously update recent information. Likewise, logistics integration confirms four high factor loadings: logistics activities are collaborated, logistics routine is coordinated, smooth coordination of logistics activities and outstanding warehouse facilities and distribution. Finally, supply chain agility lists six significant factor loadings: quickly improve customer service satisfaction, quickly improve PSS delivery, quickly reconfigure PSS SC capabilities, quickly reconfigure resource capacity, quickly adapt PSS SC operation, quickly reconfigure to customize customer order and quickly innovate PSS offerings. In total, there are 29 items that are valid and reliable as a validated survey instrument. 6. Conclusion and Future Research Underpinning by the dynamic capabilities theory, this study has extensively examined five capabilities – collaboration, knowledge transfer, service partner development, information sharing and logistics integration. The findings corroborate that collaboration has a positive effect on knowledge transfer and information sharing. However, collaboration has no direct effect to supply chain agility. Hence, through the information sharing and logistics integration, the supply chain agility has improved. Likewise, both knowledge transfers and service partner development also have a positive effect to supply chain agility. This study contributes to the body of knowledge in several ways. First, it contributes to nascent PSS research by integrating the concepts of supply chain management, dynamic capabilities, and PSS concepts into a single framework that has been validated. This study contributes by identifying factors influencing the improvement of supply chain agility, namely collaboration, knowledge transfer, service partner development, information sharing, and logistics integration. The results of this study indicate that these five capabilities positively influence supply chain agility. Secondly, by employing DC as the underpinning theory, this study contributes to extending the DC theory to the areas of PSS and supply chain management. The research demonstrates that DC fits well for application in PSS and supply chain management domains. The overall model supports collaboration, knowledge transfer, service partner development, information sharing, and logistics integration as dynamic capabilities, which have been proven to be valid and reliable. Thirdly, by utilizing data from Indonesia as a developing country, this research contributes to knowledge by elucidating the relationship between the five capabilities and supply chain agility. Such efforts add references to PSS knowledge, which is rarely studied, especially in developing countries, as most PSS research originates from developed countries, where research findings may not be applicable to developing countries. Finally, this study contributes to a validated survey instrument by defining the domain constructs and developing measurement items. Furthermore, the research obtained standard factor loadings for each item, which are useful for determining the relative importance of each capability that can be utilized to enhance supply chain agility. The rigorous process for developing the validated survey instrument makes this instrument reliable and applicable for future research. This study offers practical contributions to all stakeholders in the motorcycle industry in Indonesia, as well as other countries sharing similar characteristics to Indonesia. The research provides insights for industry participants to understand the factors influencing supply chain agility improvement and identify which items should be given priority, as evidenced by factor loadings. This greatly assists practitioners in effectively allocating limited resources to enhance supply chain agility. Second, motorcycle industry practitioners can leverage the research outcomes highlighting the significance of long-term collaboration with supply chain stakeholders, particularly with main dealers and service partners. This collaboration aims to deliver PSS. Main dealers play a pivotal role in supporting service partners' knowledge and development, as well as in maintaining logistic integration and sharing information to enhance supply chain agility. Third, the motorcycle industry, being a knowledge-intensive sector that extends beyond merely selling products to also include services, requires manufacturers as the holders of knowledge to disseminate this knowledge to service partners through main dealers. Training and workshops can be provided to continuously update and enhance the knowledge of main dealers and service partners. Finally, good coordination is essential for both information sharing and logistics integration. Effective coordination of information flow can be achieved through the availability of transparent and sustainable information flow, as well as by maintaining good communication relationships through frequent meetings and communication. Meanwhile, effective logistics integration is measured by harmonious coordination from manufacturing to main dealers and service partners. This study subject to several limitations but can also be seen as the direction of the future studies. First, the limitation of this study is the sampling that is limited to a motorcycle industry in Indonesian firms. To make a generalization of the result of this study, future research should use general industry in the broader geographical areas and then make comparisons with papers published from many other countries. Second, this study focuses on specific motorcycle industry with only three stakeholders in the SC, service partner, intermediaries and manufacturer, but not including other supplier in the upstream process such as spare part and raw material suppliers. Future research should include them to corroborate the impact of their capabilities in supply chain agility. Furthermore, customers as stakeholders are crucial to be involved in the PSS development process, which can be done by conducting surveys and interviews with consumers to understand their roles and expectations. Third, the proposed model has demonstrated 47 per cent of the variance for supply chain agility. Further research should examine the possibility of knowledge transfer and information sharing direct effect to supply chain agility. Fourth, this study utilizes cross-sectional survey data, indicating that data collection captures a snapshot in time to assess supply chain agility resulting from PSS delivery. However, supply chain agility is subject to change over time. It would be particularly intriguing if the research could be conducted longitudinally to observe the factors contributing to these changes. Finally, future research may influence by moderating factors. For example, it would be intriguing to investigate the impact on the duration of cooperation, technological capabilities and different culture factors to observe the effect of different kind of capabilities to supply chain agility. Declaration of Conflicting Interests The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. Funding The authors received financial support for the research from the Directorate of Research, Technology, and Community Service, Directorate General of Higher Education, Research, and Technology, Ministry of Education, Culture, Research, and Technology, in accordance with the Research Contract Number: LLDIKTI:003/SP2H/PT/ LL7/2024 and 561A/WM01.5/N/2024. References Adrodegari, F., & Saccani, N. (2017). Business models for the service transformation of industrial firms. 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Achieving Supply Chain Agility Through Product–Service Systems Offering

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Abstract:

Purpose: This paper aims to examine the role of collaboration, knowledge transfer, service partner development, information sharing and logistics integration on product–service systems supply chain agility.

Design/methodology/approach: Data were collected from 405 official motorcycle service partners in Indonesia using questionnaires and were analyzed using structural equation modelling.

Findings: Collaboration has a significant impact on knowledge transfer and information sharing. Information sharing and logistics integration as mediation to improve product–service systems supply chain agility. Likewise, knowledge transfers and service partner development also as mediation to enhance supply chain agility. As a result, collaboration has no significant direct impact to supply chain agility.

Research limitations/implications: Given the state of the sampling refers to specific industry, so the generalization of the results will be limited.

Practical implications: The model provides insight for managers on how collaboration, knowledge transfer, service partner development, information sharing and logistics integration positively affect product–service systems supply chain agility. Using measurement items of this study, managers can determine and evaluate the current state and formulate strategies to improve their product–service systems supply chain capabilities.

Originality/value: The contribution of this study lies in investigating the role of dynamic capabilities for product–service systems offering to improve supply chain agility. This study provides benefits for academicians and industry by filling the gap of the nascent study in product–service systems and supply chain agility.

Keywords: supply chain agility, product–service systems, dynamic capabilities, collaboration

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1. Introduction

In recent decades, conventional manufacturing firms have grappled with significant challenges concerning their resources, including both personnel and materials. These challenges are so pressing that simply delivering a product is no longer sufficient; instead, there is a need to enhance the product's value within the context of business objectives (Bustinza, Vendrell-Herrero & Chiappetta-Jabbour, 2024). Among many solutions, an offering of product–service systems (PSS) as a bundle offering of product and service sound reassuring. PSS process is often called as part of effort as a servitization of the product manufacturing companies (Xing, Liu & Davies, 2023), and it refers to a novel business model innovation where a combination of product and service offerings acts as a driving force for innovation, aiming to create uniqueness and differentiation (Marcon, Marcon, Ayala, Frank, Story, Burton et al., 2022). Yet, the difficulty lies in how manufacturing companies will successfully provide their combined product and service packages to customers.

Limited research has investigated how manufacturing companies compensate for their inadequate service capabilities through collaboration and partnerships. (Alzoubi, Elrehail, Hanaysha, Al-Gasaymeh & Al-Adaileh, 2022; Ayala, Paslauski, Ghezzi & Frank, 2017). Considering these needs, manufacturing companies ought to collaborate closely to ensure that services are delivered with enhanced value to customers (Ayala, Gaiardelli, Pezzotta, Le Dain & Frank, 2021). Long-term collaboration is especially essential for the value enhancement of PSS that prioritize offering bundled products and services rather than just products alone (Stegehuis, von Raesfeld & Nieuwenhuis, 2023). Primarily within the automotive industry, PSS has become indispensable for customers, largely due to their limited knowledge to independently conduct product maintenance. (Dewi, Hermanto, Pittayachawan & Tait, 2023).

In the contemporary global business landscape, especially within the automotive sector, agility has emerged as a pivotal element for companies striving to gain a competitive edge (Basu, Abdulrahman & Yuvaraj, 2023). Agility refers to several characteristics: innovativeness, flexibility, speed and responsiveness (Al-Omoush, Palacios-Marqués & Ulrich, 2022; Kim & Chai, 2017; Shukor, Newaz, Rahman & Taha, 2021). Therefore, to achieve agility and provide Product-Service Systems, it is necessary to engage a network of stakeholders throughout the supply chain (SC). (Marcon et al., 2022). Collaboration among stakeholders along the SC is inherently complex in the Product-Service Systems process. Achieving successful collaboration necessitates the active participation of manufacturers to enhance supply chain capabilities and develop PSS SC capabilities among all stakeholders in the supply chain network (Dewi, Hermanto, Sianto, Mulyana, Trihastuti & Gunawan, 2024; Dewi & Hermanto, 2023).

To meet these needs, it is crucial for manufacturers to collaborate with actors in the SC network to ensure the delivering of PSS at the best value for customers (Al-Doori, 2019; Ayala, Gerstlberger & Frank, 2019). Close coordination among stakeholders in the supply chain network is essential for PSS to deliver enhanced value to customers. This focus entails providing a comprehensive package of both products and services, rather than solely the tangible product itself (Marcon et al., 2022). PSS are considered a component of the manufacturer's duty to prolong the product life cycle. This involves collaborating with service providers responsible for maintaining the product and delivering associated services (Dewi & Hermanto, 2022). Therefore, manufacturers, being the strongest actor in the supply chain, typically offer their support by providing access to knowledge, fostering partner development, sharing technical expertise, and supplying other necessary resources required by the service suppliers (Ayala et al., 2019).

To investigate the relationship with actors in the SC network, the Dynamic Capabilities (DC) is used as an underpinning theory. DC is utilized to understand how the SC capabilities of manufacturers can be transferred to service suppliers. It is well known that the firms that possess resources that are valuable, rare, not substitutable are difficult to imitate (Teece, 2007). However, the motivation to collaborate with external partners to provide PSS can outweigh the hurdle of sharing resources and capabilities (Story, Raddats, Burton, Zolkiewski & Baines, 2017). The cooperation of the process with service suppliers may involve logistics integration, information sharing, knowledge transfers and service supplier development.

Few studies have investigated how the process of collaboration among manufacturers, intermediaries and service suppliers all together as SC networks closely collaborate to deliver PSS. For example, Story et al. (2017) confirmed that critical capabilities for multi actors in the SC to be able to deliver PSS are product–service innovation, customer focused, good synergy product-service and coordination product-service. They also highlighted that the provision of PSS can only be developed under collaboration and cooperation within the SC network. Further, Ayala et al. (2019) demonstrated that the support and collaboration from service suppliers is paramount as the PSS is completely delegated to the service suppliers. Therefore, building knowledge and partner development are crucial to manage the service suppliers' capabilities. They found that offering, knowledge related to PSS and joint PSS development positively affect PSS delivery. However, little is known about the link among PSS SC capabilities required such as collaboration, knowledge transfer, service supplier development, logistic integration and information sharing to become agile. A quantitative survey of 405 motorcycle service suppliers in the Indonesian motorcycle industry was collected. Our results confirm that collaboration has a positive impact on knowledge transfer and information sharing, while knowledge transfer, service partner development and information sharing, logistics integration function as mediation to improve supply chain agility.

2. Theoretical Background and Hypotheses Development

In this section, a theoretical framework is built to confirm the relationship between collaboration, transfer knowledge, service partner development, information sharing, logistic integration and supply chain agility, accompanied with the hypothesis relating their relationships.

2.1. Literature Review of PSS

Our literature review in PSS has shown adoption of PSS within organizations, using the business model canvas as a framework. The business model canvas has been utilized by researchers like Adrodegari, Saccani, Kowalkowski and Vilo (2017), Kindström and Kowalkowski (2014) and Salwin, Jacyna-Golda, Kraslawski and Waszkiewicz (2022) to identify various capabilities necessary for PSS namely customer segments, customer relationships, distribution channels, revenue stream, key resources, key activities, key partners, value proposition, and cost structures.

Several empirical studies of PSS used a qualitative case study method. These studies identified the different factors that impact the PSS delivery (Parida, Sjödin, Wincent & Kohtamäki, 2014) investigated the distinctive capabilities related to PSS delivery in Swedish and Finnish manufacturing companies. This study revealed four critical capabilities: network management, service delivery network management, and integrated development for service and product–service value offerings. Reim, Sjödin and Parida (2019) investigated the capabilities needed to adopt a PSS and identified service extensión, service benchmarking, digitalization to support PSS and customer creation.

Resource-based theory, encompassing concepts like the resource-based view (RBV) and dynamic capabilities, has been the primary theory applied in both the PSS and SC fields (Ayala et al., 2019). RBV stands out as a leading strategy for enhancing an organization's resources and capabilities to gain competitive advantage (Madhani, 2010). It emphasizes leveraging existing organizational resources to sustain performance by capitalizing on internal strengths, addressing weaknesses, and mitigating external threats (Priem & Butler, 2001). Wallin, Parida and Isaksson (2015) conducted a three-year study on an aerospace company to examine the progression of its adoption of PSS. The research unveiled the operational capabilities utilized throughout this process, such as fostering a PSS-friendly environment, facilitating networking collaborations, engaging in cooperation with external partners, encouraging internal partnerships, and developing expertise in PSS. However, RBV static nature renders it inadequate for coping with the rapid fluctuations in competitive markets, resulting in diminishing resource advantages over time (Teece, 2007).

Dynamic Capabilities (DC) assists organizations' capabilities to quickly respond to the erratic changes in environment by sensing, seizing and reconfiguring internal and external resources and capabilities through the improvement of the micro foundation (Pitelis, Teece & Yang, 2023). Sensing is the capability of understanding the internal and external threat by observing the surrounding environment (Teece, 2007). Seizing is the next capabilities required to pursue the opportunity (Teece, 2007). Then finally, reconfiguring is needed for the possibilities of chasing the opportunity through the offering of PSS (Teece, 2007).

DC fits well with the idea of cooperation and build capabilities within SC network (Siems, Land & Seuring, 2021). Therefore, DC is ideal as underpinning theory in this study as it is consistent with the supply chain and PSS concept. The supply chain capabilities required for PSS offering are quite challenging to be developed alone (Dewi et al., 2023; Trihastuti, Dewi, Santosa & Yuliawati, 2024). They need to be enhanced in the network supporting by the interaction stakeholders in the SC, such as: manufacturers, intermediaries, suppliers and service partners (Beske, Land & Seuring, 2014).

Ayala et al. (2019) introduced a model incorporating four DC aimed at maximizing the benefits of PSS. Their research highlighted the significance of PSS offerings, resources, and activities, with service supplier development exhibiting different behaviors based on whether the PSS was product-oriented or results-oriented. Ayala et al. (2017) also underscored the importance of knowledge sharing among supply chain partners. Raddats, Zolkiewski, Story, Burton, Baines and Ziaee-Bigdeli (2017) outlined four capabilities essential for manufacturers in collaborative settings: knowledge development, PSS enablement, PSS development, and risk management. Story et al. (2017) proposed six DC for delivering PSS, emphasizing aspects like innovation, interaction processes, actor, business culture evolution, working with other actors and infrastructure development. The current research focuses on how manufacturers balance innovation in both products and services while maintaining effective collaboration with service partners, primarily prioritizing customer-centric perspectives.

Methods	Theory	Capabilities	References
Qualitative	Business Model Canvas	Customer segments, customer relationships, distribution channels, revenue stream, key resources, key activities, key partners, value proposition, and cost structures	Adrodegari & Saccani, 2017; Salwin et al., 2022; Kindström & Kowalkowski, 2014
Qualitative	-	Network management, service delivery network management, integrated development for service, and PSS offering	Parida et al., 2014
Qualitative	-	Value proposition, customer segmentation, PSS elements, network partners and value creation	Reim et al., 2019
Qualitative	RBV	PSS-friendly environment, facilitating networking collaborations, engaging in cooperation with external partners, encouraging internal partnerships, and developing expertise in PSS	Wallin et al., 2015
Quantitative	DC	PSS offering, resource, activity, service supplier development	Ayala et al., 2019
Qualitative	DC	Knowledge development, PSS enablement, PSS development and risk management	Story et al., 2017
Qualitative	DC	Innovation, interaction processes, actor, business culture evolution, working with other actors and infrastructure development	Story et al., 2017
Qualitative	DC	Knowledge development, external collaboration with external partners	Paiola, Khvatova, Schiavone & Jabeen, 2022
Quantitative	Organizational processing theory	information processing capability and data integration with customers and suppliers	Dalenogare et al., 2022
Qualitative	-	External environmental factors, internal firm factors, capabilities, business models and processes, and value creation and interaction	Burton et al., 2024

Table 1. The summary of the PSS literature review

Recently, research on PSS has shifted towards digitalization, for example, Rapaccini, Paiola, Cinquini and Giannetti (2023) confirmed that Knowledge-intensive business services firms have the capacity to serve as origins, facilitators, and conveyors of knowledge. Additionally, SC should collaborate with external partners to contribute to the transfer and development of knowledge. On the contrary, Burton, Story, Zolkiewski and Nisha (2024) employed the capability paradox, which describes the obstacles towards the digitalization of PSS, namely external environmental factors, internal firm factors, capabilities, business models and processes, and value creation and interaction. Further, (Dalenogare, Le Dain, Benitez, Ayala & Frank, 2022) found that information processing capability and data integration with customers and suppliers improve PSS. The summary of the PSS literature review is presented in the Table 1.

These studies primarily aimed at developing a model for PSS. However, they often neglected to address how capabilities were transferred to other stakeholders within the SC network. Most studies on PSS have primarily concentrated on the downstream supply chain, even those recently research that focusing on digital development, predominant focus on customer service. **Looking at the existing research gap in PSS, to gain a broader perspective and competitive advantage, an integrated approach that incorporates supply chain management concepts, particularly emphasizing agile delivery of PSS, is essential.**

Our conceptual framework is built on prior research from PSS literature review, dynamic capability literature review and supply chain management concept. From the perspective of supply chain management, Negi (2024), Panahifar, Byrne, Salam and Heavey (2018) and Pham, Nguyen, Mcdonald and Tran-Kieu (2019) found that there were key capabilities crucial for attaining competitive performance, which include long-term collaboration, logistics integration, and information sharing.

Collaboration within the supply chain is fundamental to any partnership and cooperation. Particularly in the motorcycle industry, long-term collaboration is favored over short-term cooperation due to the need for sustained network development and dynamic capabilities formation, which necessitate prolonged cooperation to align with the supply chain's objectives. In light of the changing business environment, integrating aspects of supply chain management concepts, dynamic capabilities and Product-Service Systems is essential, as well as understanding their interconnectedness to enhance supply chain agility.

The aim of this paper is to investigate the relationship of collaboration, knowledge transfer, service partner development, information sharing and logistics integration and supply chain agility. Drawing from the theoretical background outlined in this section, we can construct the conceptual framework of this paper. the following subsections elaborate on the detailed hypotheses regarding the relationships within the research model.

2.2. Logistics Integration and Supply Chain Agility

In this section, we focus on logistic integration which is defined as effectively well coordination and smooth flow of product and information (Danese, Molinaro & Romano, 2020). To investigate the relationship between logistic integration and supply chain agility, DC is used as an underpinning theory. DC has been commonly utilized to examine the company's capability to constantly rebuild, integrate, renew its crucial capability and resources to respond to rapid changing environment (Helfat, Finkelstein, Mitchell, Peteraf, Singh, Teece et al., 2009). DC should be noted as difficult to be developed alone as they should be enhanced together within supply chain network (Pitelis et al., 2023). Therefore, dynamic capabilities can elucidate how collaboration among companies can result in improved agility performance. The unique resources possessed by each firm, which are rare, difficult to replicate, valuable, and irreplaceable, cannot be easily replicated by another firm. However, under a collaborative framework, a firm's performance is influenced not only by its internal resources but also by the external resources within the supply chain network (Teece, 2023).

Logistic integration involves seamless and coordinated logistic activities such as flow of product and information (Jafari, Eslami & Paulraj, 2022). Such collaboration impacts on a transparent connection among stakeholders in the SC (Alzoubi et al., 2022). Logistic integration brings many benefits to the performance of stakeholders in the SC (manufacturers, intermediaries and service partners), such as improving product quality, operational efficiency and response to the customers (Alzoubi et al., 2022). A number of studies have reported the positive link between logistic integrations and performance (Turabi, 2024). Danese et al. (2020) also reported that the higher degree of supply chain integration impact to higher degree of supply chain performance.

SC agility is defined as the firms' capability to experience and rapidly react to market's unpredictability (Gligor, Stank, Gligor, Ogden, Nowicki, Farris et al., 2023). Agility is pointed out to several characteristics: flexibility, responsiveness, adaptability, innovativeness and speed to achieve competitive advantage (Kim & Chai, 2017).

Gligor, Gligor, Holcomb and Bozkurt (2019) and Al-Omoush et al. (2022) characterized SC agility as speed, responsiveness, flexibility and innovativeness. This study acquires these four characteristics to measure SC agility. Several characters of supply chain performance overlap with the SC agility. Hence, we hypothesized as follows:

H1. *Logistic integration has a positive relationship with supply chain agility.*

2.3. Service Partner Development and Supply Chain Agility

Service partner development refers to dynamic capabilities aimed at enhancing the capabilities of partners, involving processes designed to achieve supply chain goals through experimentation and training programs (Encinas-Bartos, Schwarzkopf & Mueller, 2024). As manufacturing companies endeavor to provide PSS, which prioritize services alongside products, the development of service partners becomes a critical step. This transformation of the supply chain paradigm involves seamlessly integrating service partners into the process (Jia, Stevenson & Hendry, 2023). Yawar and Seuring (2018, 2020) confirmed that the higher level of collaboration and integration processes lead to better supply chain performance. In line with previous studies, we argue that service partner development enables the supply chain to achieve its agility. For example, Benton, Prahinski and Fan (2020) emphasized that to remain competitive, a company must enhance its partners' capabilities to achieve the goals of the supply chain by sharing its own capabilities.

Teece (2007) identified three dynamic capabilities: sensing, seizing and reconfiguring. The sensing capability requires a process to gather data, interpreting information and allocating resources (Pitelis et al., 2023). Seizing includes the activity of identifying the opportunities and threat (Engelmann, no date). It helps companies to make a decision making procedure. Reconfiguring involves the continuous effort to cope with rapid changes in the environment (Engelmann, 2023), and requires strategic actions to build a rigor dynamic capabilities with service partners.

The achievement of supply chain goals necessitates the development of capabilities among all stakeholders involved, including the weakest partners. Manufacturers, despite possessing product knowledge, cannot solely provide PSS on their own (Ayala et al., 2021). Alternatively, they require service partners to handle the service aspect. Therefore, service partner development plays a crucial role in supporting a network of service partners by offering diverse training programs focused on product knowledge and technical expertise in product maintenance (Encinas-Bartos et al., 2024). Coşkun, Kumru and Kan (2022) and Paybarjay, Fallah-Lajimi and Hashemkhani-Zolfani (2023) noted that partner development could increase supply chain performance. Based on the above arguments, the following hypothesis is developed:

H2: Service partner development has a positive relationship with supply chain agility.

2.4. Knowledge Transfer and Service Partner Development

Knowledge transfer is defined as the capability to understand, access and share the valuable resources and knowledge (Zaid, Sleimi, Saleh & Othman, 2023). In this study, it is important to acknowledge DC as a foundational theory, particularly highlighting the functions of sensing, seizing, and reconfiguring in knowledge transfer. These three capabilities entail establishing long-term collaborations as enduring partners (sensing), exploring new knowledge and connecting it to stakeholders in the supply chain (seizing), and consistently evaluating knowledge transfer capabilities by modifying, discarding, or adding knowledge suitable to the supply chain (reconfiguring). (Kindström, Kowalkowski & Sandberg, 2013).

Knowledge is considered as one of the most paramount capability to stay in the competition, thus there is increasing interest in understanding on how effective knowledge transfer among stakeholders in the SC (Eslami, Achtenhagen, Bertsch & Lehmann, 2023). Following this argument, the knowledge transfer within the SC network is a way to access and share knowledge and valuable resources among stakeholders in the SC (Li, 2021). It is proven that the success from competition cannot be achieved by the solitaire firm itself but often embedded in the capabilities of all stakeholders in the SC (Marcon et al., 2022). Hence, the continuous exchange of knowledge within the SC network can be seen as a fruit of sustainable collaboration to improve their dynamic capabilities (Kindström et al., 2013).

In the provision of Product-Service Systems, service partners hold a critical role, especially within knowledge-intensive sectors like automotive. Ensuring that service partners can readily access the necessary knowledge for PSS delivery is imperative (Dewi et al., 2023). Moreover, there is substantial evidence confirming that supplier development serves as a method for companies to collaborate and enhance the performance of their suppliers, thus ensuring competitiveness (Saghiri & Wilding, 2021). The service partner development program serves as a mechanism for knowledge transfer. By intensifying training through supplier programs, employees of service partners can enhance their knowledge and skills (Encinas-Bartos et al., 2024). Consequently, the enhanced skills and knowledge of the service partner will reflect in an improvement in the performance of the service partner (Jia et al., 2023). Hence, the above arguments support the following hypothesis to the study:

H3: Knowledge transfer has a positive relationship with service partner development.

2.5. Information Sharing and Logistic Integration

Information sharing refers to activities of exchanging crucial information among stakeholders in the SC (Tang, Chau, Ip & Ji, 2023). The benefits of information sharing include enhancing the quality of information and information processing capability which obviously reduces the uncertainty and trust issue in collaboration (Ahmed, Khan, Najmi & Khan, 2023). For example, Bai, Govindan and Huo (2023) verified that through information sharing, all stakeholders within the supply chain can access real-time information from their counterparts, thereby reducing the bullwhip effect and enhancing both firm and supply chain performance. The readiness to share information necessitates companies exchanging strategic information within the supply chain network (Yang, Huo & Gu, 2022). Access to real-time inventory levels and demand requirements from supply chain partners enables partners to improve replenishment planning, indirectly enhancing their firm's performance (Kim & Chai, 2017).

The activity of information sharing and logistics integrations requires the partnership and cooperation among stakeholders in the SC (Bai, 2024; Bai et al., 2023). Thus, these two capabilities fit a dynamic capabilities approach that emphasize sensing, seizing and reconfiguring to achieve a high level of performance. Furthermore, a number of studies have exemplified a variety of logistics integration advantages from the power of information sharing such as lowering the inventory level and bullwhip effect (Tang, Yang, Tu & Ma, 2021). Hence, the above arguments support the following hypothesis to the study:

H4: Information sharing has a positive relationship with logistics integration.

2.6. Collaboration and Knowledge Transfer, Information Sharing, Supply Chain Agility

Collaboration is defined as two or more companies form long-term relationships to achieve one goal by sharing information, capabilities and resources (Ralston, Keller & Grawe, 2020; Ruiz-Alba, Soares & Rodríguez-Molina, 2023). This study focuses on PSS delivery by multi actors in the SC so that the collaboration among stakeholders in the SC is paramount. However, forming dynamic collaboration capabilities is not unchallenging. Underlying the value from DC, collaboration capability is valuable and hard to replicate. Several studies demonstrated that SC collaboration characterized by sharing resources, jointly planning, has many different channels to communicate and have agreement goals, has strong collaborative possibilities (Ralston et al., 2020; Zhang & Cao, 2018). SC collaboration heavily dependent on sharing resources and trust, focuses on collaborative effort to be able to offer customer-oriented PSS delivery (Marcon et al., 2022).

Previous studies found that collaborations allow firms to access to knowledge and information required leading to improve companies' performance (Ralston et al., 2020; Ruiz-Alba et al., 2023). Effective collaboration leads to a better level of transfer knowledge and information sharing (Kim & Chai, 2017). Collaboration is often seen as a way to seize business strategy within the SC network. For example, DC were utilized to promote cooperation among many actors within the SC network to enhance transparency of information sharing, technology sharing and accessibility of knowledge (Cao, Vonderembse, Zhang & Ragu-Nathan, 2010; Zhang & Cao, 2018). Likewise, collaboration is frequently seen as crucial element to supply chain agility (Dubey, Bryde, Foropon, Tiwari, Dwivedi & Schiffling, 2021). Hence, the above arguments support the following three related hypotheses:

H5: Collaboration has a positive relationship with knowledge transfer.

H6: Collaboration has a positive relationship with information sharing.

H7: Collaboration has a positive relationship with supply chain agility.

3. Research Methods

3.1. Development of Instrument

A questionnaire was developed based on a literature review conducted in section 2. Items of measurement consisted questions measuring six domain constructs: collaboration (C) is 7 items, knowledge transfer (KT) is 5 items, supplier partner development (SPD) is 5 items, information sharing (IS) is 5 items, logistics integration (LI) is 5 items and supply chain agility (SCA) is 7 items, with five-point likert scale from strongly disagree to strongly agree (Table 2). To provide validation of the preliminary stage, four academic experts in PSS and supply chain were enlisted to deliver feedback on questionnaire consistency, logical, clarity and relevance. Then an interrater agreement survey with 30 head of service partner suppliers was participated. Three criteria recommended for dropping items: (1) drop items when its mean value is less than the midpoint, (2) drop items left from (1) when $p > 0.05$ and (3) drop items left from (2) when power < 0.8. As a result, there is no items deleted so that 34 items were persisted for the questionnaire.

Code	Domain of Construct and Items	References	Factor loading
Collaboration (C) is defined as a partnership activity of creating new resources where two or more parties jointly work together to achieve mutual benefit			
C1	We sense and seize a long-term collaborative relationship with our main dealer partner based on mutual trust	Zhang & Cao, 2018	0.823
C2	We work jointly on the PSS planning with our main dealer partner	Zhang & Cao, 2018	0.817
C3	We collaborate with our main dealer partner to reconfigure PSS offering	Dubey et al., 2021	0.752
C4	We collaborate with our main dealer partner to identify and understand the customers' need	Dewi et al., 2023	0.796
C5	We have many different channels to communicate	Zhang & Cao, 2018	0.825
C6	We have agreement on the same SC agility readiness goals (deleted)	Al-Omoush et al., 2022	-
C7	We exchange knowledge and relevant information (deleted)	Zhang & Cao, 2018	-
Knowledge transfer (KT) is defined as the capability to transfer and assess knowledge among stakeholders in the SC			
KT1	Our main dealer partner transfers its knowledge of PSS to us	Ayala et al., 2017	0.856
KT2	Our main dealer partner shares its knowledge about the benefit of being agile as our goal	Al-Omoush et al., 2022	0.842
KT3	We receive knowledge about information technology that we use to deliver PSS	Dewi et al., 2023	0.844
KT4	Our main dealer partner continuously supports us to share about our customers' expectations	Dewi et al., 2023	0.807
KT5	Our main dealer partner constantly transfers knowledge of innovations for a bundle of product and service	Ayala et al., 2017	0.840
Service partner development (SPD) is defined capability to develop partner capacity by providing variety of training and reconfigure overall performance within SC			
SPD1	Our main dealer partner has ceaselessly upgrades our knowledge (deleted)	Dewi et al., 2023	-
SPD2	Several training courses has been prepared to us to increase our speed, flexibility, responsiveness and innovativeness	Dewi et al., 2023	0.872
SPD3	A service partner development programs has been provided by our main dealer partner	Ayala et al., 2019	0.843
SPD4	Our main dealer partner strengthens our capabilities to achieve supply chain agility	Ayala et al., 2019	0.808

Code	Domain of Construct and Items	References	Factor loading
SPD5	Variety training courses of product and technical service has been supplied to us	Paiola, Saccani, Perona & Gebauer, 2013; Rapaccini et al., 2023	0.814
Information sharing (IS) s defined as capability to sense and seize SC information for any stakeholders in the SC			
IS1	We share delicate information to our service partner	Lambourdiere & Corbin, 2020	0.797
IS2	Our main dealer partner are transparent to share any information	Bai et al., 2023	0.733
IS3	Information interchange is continuing and repeatedly	Kim & Chai, 2017	0.843
IS4	Our main dealer partner continuously update us with recent information	Kim & Chai, 2017	0.804
IS5	Our main dealer partner keep frequent meeting and communication (deleted)	Kim & Chai, 2017	-
Logistics integration (LI) Is defined as the capability to integrate logistics activities to create overall values to customers			
LI1	Our supply chain logistic activities are strictly collaborated	Chen & Paulraj, 2004	0.739
LI2	Our main dealer partner logistics routines are effectively coordinated with ours	Chen & Paulraj, 2004	0.725
LI3	We have a smooth coordination of logistics activities with our main dealer partner	Chen & Paulraj, 2004	0.853
LI4	Our logistics coordination is specified by outstanding warehouse facilities and distribution	Chen & Paulraj, 2004	0.842
LI5	The incoming and outgoing coordination of product distribution is completely harmonize (deleted)	Chen & Paulraj, 2004	-
Supply chain agility (SCA) as the SC capability to quickly adapt to fluctuating, erratic and unstable working environment			
SCA1	We always quickly improve our PSS level of customer satisfaction	Kim & Chai, 2017	0.810
SCA2	We always quickly improve our PSS delivery reliability	Kim & Chai, 2017	0.842
SCA3	We always quickly reconfigure PSS SC capabilities to adopt with changing market needs	Kim & Chai, 2017	0.824
SCA4	We always quickly reconfigure SC resource capacity to respond to uncertain demand	Boon-itt, Wong & Wong, 2017	0.833
SCA5	We always quickly adapt PSS SC operation to decrease service lead time	Al-Omoush et al., 2022	0.873
SCA6	We always quickly reconfigure our capabilities to customize customer order	Shakor et al., 2021	0.657
SCA7	We always quickly innovate our PSS offerings	new	0.788

Table 2. Theoretical domain of constructs and items

3.2. Data Collection and Sampling

The data from this study were collected from the Indonesian motorcycle service partner from December 2022 to June 2023. The list of participants was randomly chosen from sampling frame of 8450 service partner from five motorcycle brands, with the criteria that the head of service has working experience for at least twelve months. In total, nine hundred fifty questionnaires were distributed, the response came back with 405 questionnaires (42.6 % response rate). The data has been checked for non-response bias. The Levene's test for equality of variance and a t-test equality of means performed the early and late wave were not statistically significant.

The demographics profile of the participants are as follows: the participants are mostly males (95.8%) with the education of senior high school or higher with almost 99.3%. The service partners can be identified as small companies with employees less than 10 (89.6%) and originated mostly from Java island (70.6%), also have more than 10 years' collaboration with their brands (67.2%). This is because Java known as a the most populated island in Indonesia. Likewise, the motorcycle brand in Indonesia is dominated by one brand who became the majority participants in this research (72.6%).

4. Result

4.1. Construct Validity and Reliability

Confirmatory factor analysis (CFA) was needed to examine the validity of all variables utilized in this study using AMOS (version 26). The results of CFA and factor loadings are presented in Table 1. Using Structural Equation Modelling (SEM) requires several Goodness of Fit (GOF) indices to assess fit between the observed covariance matrix and the hypothesized model. Hu and Bentler (1998) and Yu (2002) introduced the cut off value of GOF as guidance $p > 0.01$, norm $\chi2 \leq 2$, RMSEA < 0.05, SRMR < 0.07, CFI > 0.96 and TLI > 0.95. Using this guidance resulted several items to be deleted from the model: C6, C7, SPD1, IS5 and LI5. The overall model fit and standard items loading indicated the evidence of convergent validity (Hair, Black, Babin, Anderson & Tatham, 2010). Then, the values of Cronbach's alpha are between 0.871 and 0.928 to confirm the scale reliability of the six constructs (Hair et al., 2010).

4.2. Discriminant Validity

Discriminant validity aims to ensure that the construct has powerful relationships with its constructs (Hair et al., 2010). Discriminant validity among the six constructs are attained by the value of average variance extract (AVE) for each construct is bigger than the value of the square correlation between the corresponding construct (Table 3).

	IS	CO	KA	PD	LI	SCA
IS	0.795					
CO	0.392	0.802				
KA	0.385	0.759	0.838			
PD	0.373	0.705	0.777	0.834		
LI	0.634	0.474	0.454	0.513	0.794	
SCA	0.508	0.315	0.336	0.433	0.680	0.806

Table 3. AVE and square inter-construct correlation value

4.3. Common Method Bias

We utilized Harman's single-factor test to investigate the Common Method Variance (CMV) (Podsakoff, MacKenzie, Lee & Podsakoff, 2003), all items in the constructs were placed to one factor, using maximum likelihood extraction revealed AVE of 35% showed no CMV exists. Further examination of CMV, a common latent factor (CLF) was added up the measurement model (MacKenzie, Podsakoff & Podsakoff, 2011). By adding CLF to all observed items in the CFA model, the result revealed that the regression weights value deviation of CFA model without and with CLF were smaller than 0.2, indicating that CMV was not present.

4.4. Assessment of Structural Model and Result of Hypotheses

The result of the proposed structural model is presented in Figure 1, the model produced a good fit model with normed $\chi2$= 1.67; SRMR=0.04; RMSEA=0.04; CFI=0.97; TLI=0.97. The Bollen-Stine bootstrapping with 2000 random bootstrap samples produced a p-value of 0.06 which guarantees the fit of the structural model. The parsimonious of the model is guaranteed with PCFI value of 0.88.

The six hypotheses were investigated using SEM technique. The result exhibit that logistics integration has a positive relationship with supply chain agility (0.654 at p < 0.001), supporting H_1. Hypothesis H_2 of service partner development on supply chain agility is supported by path coefficient 0.210 at p < 0.002. Likewise, H_3 is supported by evidence that knowledge transfer has a positive relationship with service partner development (0.791 at p < 0.001). Furthermore, H_4 is supported as shown that information sharing has a positive relationship with logistics integration (0.660 at p < 0.001). Collaboration has a positive relationship with knowledge transfer as postulated in H_5 (0.779 at p < 0.001). H_6 is the result indicates that collaboration has a positive relationship with information sharing (0.434 at p < 0.001). Finally, H_7 shows that collaboration has no direct significant impact to supply chain agility. The values of R^2 for knowledge transfer, information sharing, service partner development, logistics integration and supply chain agility are 0.61, 0.19, 0.63, 0.43. 0.47.

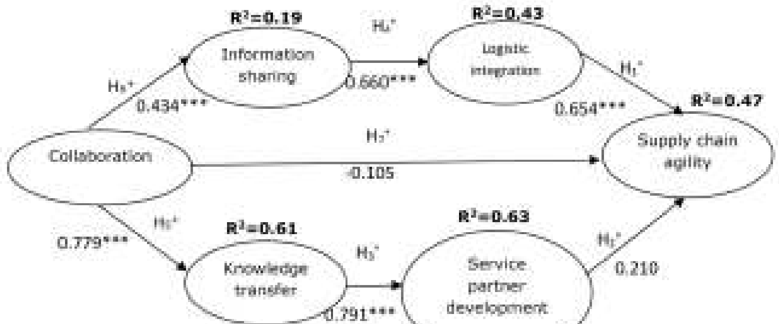

Figure 1. Result of the structural model

5. Discussion

This study contributes to scarce literature on PSS and supply chain management (SCM) concept by integrating the concept of supply chain for PSS offering underpinning by DC. This study plays a part in existing PSS and SCM literature by developing six capabilities: collaboration, knowledge transfer, service partner development, information sharing and logistic integration to improve SC agility. Pointedly, this study promotes to the PSS, SCM and DC with following respects.

First, this study highlights the collaboration guide foster cooperation behaviors including transfer knowledge and information sharing, as to the positive relationship findings demonstrated by hypothesis 5 (H_5) and hypothesis 6 (H_6), respectively. For example, knowledge transfer and information sharing cannot be attained before collaboration is formalized. The threat of sharing crucial information and important knowledge can be refrained from if only the firms have strategic long term cooperation and collaboration. DC as an underpinning theory in this study, facilitate the understanding of the SC to be able to cooperate, collaborate, integrate, acquire and reconfigure resources and capabilities within SC. Ramjaun, Rodrigues, and Kumar (2024) and Dubey et al. (2021) confirmed that collaboration is primarily serve as a function of integration within SC stakeholders. Further, the finding in this study is consistent with Wang and Hu (2020) who confirmed that the level of transfer knowledge has influenced by the level of strategic cooperation among SC stakeholders. The finding in this study also agree with Panahifar et al. (2018) that showed information sharing heavily impacted from the fruit of the long-term collaboration among stakeholders in the SC. The long-term collaboration indicates stakeholders within SC have enhanced mutual trust leading to mutual benefits and goals.

Second, this study demonstrates that service partner development required to be preceded by the transfer knowledge. By means of this, service partner development will be clearly guided by knowledge transfer, certainly the knowledge transfer has substantial positive impact on service partner development, as demonstrated by hypothesis 3 (H_3). This finding is consistent with previous research of Beske et al. (2014) that knowledge transfer can be transferred through supplier development program. Likewise, Evers and Purwaningrum (2013) found that flow of transfer knowledge to the other partners is mediated by the partner development.

Third, this study demonstrates that information sharing has significant positive impact towards logistics integration, as demonstrated by hypothesis 4 (H_4). The benefits of information sharing include enhancing the quality of information and information processing for all stakeholders in the SC so that significantly helps firms to handle with uncertainty and minimize the bullwhip effect. This obviously will increase the certainty to make logistics decisions. The finding of this study is consistent of previous study of Sundram, Chhetri and Bahrin (2020) that through information sharing have been considerably beneficial to many logistics activities.

Fourth, this study demonstrates the direct link of collaboration to supply chain agility is not significant, as demonstrated by hypothesis 7 (H_7). It means that the relationship of collaboration to supply chain agility is fully mediated by knowledge transfer, service partner development and information sharing, logistics integration. Collaboration is as base of any alignment in the SC such as knowledge transfer, service partner development, information sharing and logistics integration. For example, coordination among stakeholders in the SC includes sharing key information. Logistics integration is also a form of close collaboration within the SC as some critical information such as production plan, demand forecast and inventory level are shared in the SC. As a result of this close collaboration, this study marks that there is positive impact of service partner development, as demonstrated by hypothesis 2 (H_2) and logistics integration to supply chain agility, as demonstrated by hypothesis 1 (H_1).

The numerical results regarding collaboration identify five items with substantial factor loadings: long-term collaborative relationships, jointly PSS planning, collaborate to reconfigure PSS, understand customers' need and has many different channels to communicate. Further the findings on knowledge transfer list five items with high factor loadings: transfer knowledge from main dealers to service partners, share knowledge about being agile, knowledge of information technology, share of customers' expectations and constantly transfer knowledge of PSS. Next, the findings on service partner development recognize four significant factor loadings: several training courses have been prepared, availability of service partner development programs, strengthen capabilities to improve agility and variety training courses for PSS. Information sharing confirm four high factor loadings: share delicate information, transparent to share information, information interchange is continuing, continuously update recent information. Likewise, logistics integration confirms four high factor loadings: logistics activities are collaborated, logistics routine is coordinated, smooth coordination of logistics activities and outstanding warehouse facilities and distribution. Finally, supply chain agility lists six significant factor loadings: quickly improve customer service satisfaction, quickly improve PSS delivery, quickly reconfigure PSS SC capabilities, quickly reconfigure resource capacity, quickly adapt PSS SC operation, quickly reconfigure to customize customer order and quickly innovate PSS offerings. In total, there are 29 items that are valid and reliable as a validated survey instrument.

6. Conclusion and Future Research

Underpinning by the dynamic capabilities theory, this study has extensively examined five capabilities – collaboration, knowledge transfer, service partner development, information sharing and logistics integration. The findings corroborate that collaboration has a positive effect on knowledge transfer and information sharing. However, collaboration has no direct effect to supply chain agility. Hence, through the information sharing and logistics integration, the supply chain agility has improved. Likewise, both knowledge transfers and service partner development also have a positive effect to supply chain agility.

This study contributes to the body of knowledge in several ways. First, it contributes to nascent PSS research by integrating the concepts of supply chain management, dynamic capabilities, and PSS concepts into a single framework that has been validated. This study contributes by identifying factors influencing the improvement of supply chain agility, namely collaboration, knowledge transfer, service partner development, information sharing, and logistics integration. The results of this study indicate that these five capabilities positively influence supply chain agility. Secondly, by employing DC as the underpinning theory, this study contributes to extending the DC theory to the areas of PSS and supply chain management. The research demonstrates that DC fits well for application in PSS and supply chain management domains. The overall model supports collaboration, knowledge transfer, service partner development, information sharing, and logistics integration as dynamic capabilities, which have been proven to be valid and reliable. Thirdly, by utilizing data from Indonesia as a developing country, this research contributes to knowledge by elucidating the relationship between the five capabilities and supply chain agility. Such efforts add references to PSS knowledge, which is rarely studied, especially in developing countries, as most PSS research originates from developed countries, where research findings may not be applicable to developing countries. Finally, this study contributes to a validated survey instrument by defining the domain constructs and developing measurement items. Furthermore, the research obtained standard factor loadings for each item, which are useful for determining the relative importance of each capability that can be utilized to enhance supply chain agility. The rigorous process for developing the validated survey instrument makes this instrument reliable and applicable for future research.

This study offers practical contributions to all stakeholders in the motorcycle industry in Indonesia, as well as other countries sharing similar characteristics to Indonesia. The research provides insights for industry participants to understand the factors influencing supply chain agility improvement and identify which items should be given priority, as evidenced by factor loadings. This greatly assists practitioners in effectively allocating limited resources to enhance supply chain agility. Second, motorcycle industry practitioners can leverage the research outcomes highlighting the significance of long-term collaboration with supply chain stakeholders, particularly with main dealers and service partners. This collaboration aims to deliver PSS. Main dealers play a pivotal role in supporting service partners' knowledge and development, as well as in maintaining logistic integration and sharing information to enhance supply chain agility. Third, the motorcycle industry, being a knowledge-intensive sector that extends beyond merely selling products to also include services, requires manufacturers as the holders of knowledge to disseminate this knowledge to service partners through main dealers. Training and workshops can be provided to continuously update and enhance the knowledge of main dealers and service partners. Finally, good coordination is essential for both information sharing and logistics integration. Effective coordination of information flow can be achieved through the availability of transparent and sustainable information flow, as well as by maintaining good communication relationships through frequent meetings and communication. Meanwhile, effective logistics integration is measured by harmonious coordination from manufacturing to main dealers and service partners.

This study subject to several limitations but can also be seen as the direction of the future studies. First, the limitation of this study is the sampling that is limited to a motorcycle industry in Indonesian firms. To make a generalization of the result of this study, future research should use general industry in the broader geographical areas and then make comparisons with papers published from many other countries. Second, this study focuses on specific motorcycle industry with only three stakeholders in the SC, service partner, intermediaries and manufacturer, but not including other supplier in the upstream process such as spare part and raw material suppliers. Future research should include them to corroborate the impact of their capabilities in supply chain agility. Furthermore, customers as stakeholders are crucial to be involved in the PSS development process, which can be done by conducting surveys and interviews with consumers to understand their roles and expectations. Third, the proposed model has demonstrated 47 per cent of the variance for supply chain agility. Further research should examine the possibility of knowledge transfer and information sharing direct effect to supply chain agility. Fourth, this study utilizes cross-sectional survey data, indicating that data collection captures a snapshot in time to assess supply chain agility resulting from PSS delivery. However, supply chain agility is subject to change over time. It would be particularly intriguing if the research could be conducted longitudinally to observe the factors contributing to these changes. Finally, future research may influence by moderating factors. For example, it would be intriguing to investigate the impact on the duration of cooperation, technological capabilities and different culture factors to observe the effect of different kind of capabilities to supply chain agility.

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