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The Product–Service System Supply Chain Capabilities and Their Impact on Sustainability Performance: A Dynamic Capabilities Approach

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Abstract: In response to competition and other market challenges, many consumer manufacturing companies are offering Product–Service Systems (PSSs) in order to improve their sustainability performance. This paper aims to examine the relationship between the PSS supply chain (SC) capabilities and sustainability performance. It empirically investigates a framework that hypothesises the impact of seven PSS SC capabilities on sustainability performance. Data were collected from 447 official motorcycle service partners in Indonesia and analysed using structural equation modelling. The findings reveal that innovative service delivery and sustainable product–service capability positively affect sustainability performance, whereas partner development, reflexive control, and re-conceptualisation positively affect sustainable product–service capability. The results also validate that collaboration and knowledge assessment do not directly affect sustainability performance. A contribution of this study is the innovative use of quantitative methods to provide empirical evidence that the PSS SC capabilities can contribute to sustainability performance, directly and indirectly. It also broadens the utilisation of Dynamic Capabilities (DCs) in PSS SC research. The findings also guide managers and decision-makers in the implementation of the PSS SC capabilities required to enhance sustainability performance.

Keywords: Product–Service Systems; supply chain capabilities; sustainability performance; dynamic capabilities

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1. Introduction

Due to increased competition and global supply chain challenges in product markets, manufacturers have changed their business model from the traditional purely product-centred offerings to an integrated bundle of product and service offerings, known as PSSs [1]. Such a condition brings challenges for manufacturers, mainly because they do not have existing capabilities to provide the delivery service systems or to service operational processes and the customer interface [2]. Few studies have explored how manufacturers enhance their capabilities to implement the PSS offering [3]. Creating new resources to support the PSS itself is a complex process. It involves creating capabilities through internal and external interaction, collaboration, and learning to develop new knowledge and skill [3]. Hence, the manufacturers can collaborate with a network of partners that provide service-related capabilities called service partners [4].

Several studies have assessed the capabilities required to deliver the PSS [5]. For example, a quantitative survey of 104 Brazilian and Italian product companies revealed that the capabilities required are the service offering, resource base, and activity [4]. Other studies suggest that customer-linked service, the service delivery process, and the service system arrangement are essential [6]. Raddats et al. [5] identified four capabilities that manufacturers should use in collaborative arrangements: knowledge development, PSS enablement, PSS development, and risk management. Story et al. [7] proposed six capabilities for providing a PSS: innovation, interaction processes, actor, business culture evolution, working with other actors, and infrastructure development. The extant literature on PSSs supports the claim that Dynamic Capabilities have been primarily utilised as a theoretical foundation in PSS studies. However, it has been noted that the literature mainly focuses on the customers and services. Furthermore, Raddats et al. [5] suggested that the intra-firm capability base used in the dynamic and complex environment would not be adequate to deliver the PSS. Hence, the integration and collaboration between service companies and manufacturers in the SC network represent the PSS SC capabilities required to deliver the PSS.

The Sustainable Supply Chain Management (SSCM) concept is appropriate to address the concerns regarding collaboration between manufacturers and service companies to provide the PSS required to achieve sustainability performance. The concept of SSCM is used to complement PSSs for two reasons. Firstly, the PSS literature is mostly focused on the development of knowledge for the customer, service, and network delivery capabilities [4,5,8] and does not consider the product life cycle concept. Secondly, most PSS studies focus on the economic aspects of sustainability with a notable exception being Annarelli et al. [9] who define PSS aims for sustainability on economic, social, and environmental aspects. The SSCM concept covers the product life concept throughout the product life cycle and aims for sustainability by balancing environmental, economic, and social aspects [10].

Our literature review on SSCM has shown several SC capabilities that support sustainability. For example, Beske [11] revealed five SC capabilities including knowledge assessment, partner development, co-evolving, re-conceptualisation, and reflexive control to achieve sustainability performance. Beske et al. [10] enhanced their previous model from Beske [11] by adding SSCM practices including collaboration, SC orientation, SC continuity, risk management, and pro-activity. Other studies have also contributed towards the development of the DCs required for manufacturers to achieve effective sustainability performance [12,13]. Gruchmann et al. [12] proposed similar DCs to those of Beske et al. [10] and added in logistic-leveraging capabilities to achieve sustainability performance. Sustainable product–service capability is also a key determinant for sustainability performance [14,15]; hence, it is included in the PSS SC capabilities.

Much of the PSS literature has considered an integrated perspective involving manufacturer SC capabilities, but with most focus on developing downstream SC capabilities. Therefore, an integrated perspective involving SSCM will provide a broader perspective of the relationship between PSS SC capabilities and sustainability performance. This paper contributes to the body of knowledge on this topic by addressing a gap in the literature: only a limited number of previous studies have examined sustainability performance within the PSS context. A further contribution is providing empirical evidence that focuses on testing for a positive relationship between the PSS SC capabilities and sustainability performance. Finally, this research contributes by extending the use of dynamic capabilities theory by applying it to the PSS and SSCM areas. This study shows empirically how dynamic capabilities fit well to the specific application of investigating the relationship between the PSS SC capabilities and sustainability performance. This paper has two main research questions: "What are the PSS SC capabilities affecting the sustainability performance?" and "How do the PSS SC affect the sustainability performance?". To answer these research questions, this study identified seven PSS SC capabilities: collaboration, knowledge assessment, partner development, reflexive control, re-conceptualisation, innovative service development and sustainable product–service capability. A quantitative survey of 447 motorcycle service partners in the Indonesian motorcycle industry was collected. Our results show that innovative service delivery and sustainable product–service capability positively affect sustainability performance, whereas partner development, reflexive control, and re-conceptualisation positively affect sustainable product–service capability. Further, collaboration and knowledge assessment do not directly affect sustainability performance.

2. Theoretical Background and Hypotheses Development

The following section of the paper will review key literature in order to demonstrate how the sixteen hypotheses have been formulated.

2.1. Dynamic Capabilities Theory

This study adopts the DCs theory [16], which has been widely used in PSS and SSCM studies. The DCs theory works best when collaborating with two or more organisations' capabilities and resources in the SC [11] because DCs are challenging to develop in isolation and should be developed together within a network [17]. In this study, the DCs are required to be developed by the interactions among relevant actors in the SC, namely: manufacturers, intermediaries, and service partners. There is considerable overlap between DCs and SSCM; they share identical business environment characteristics when the market demand is unpredictable, product success is based on collaboration, and sustainability performance is their goal for competitive advantage [11]. The concept of SSCM and DCs then is used to redefine the PSS.

The DCs perspective demonstrates that the external parties' capabilities, such as the suppliers' and service partners' capabilities, are the major driver for collaboration [16]. Within the PSS context, the DCs theory is used for sensing the new opportunities to provide the PSS, seizing the capabilities to convey the opportunities, and reconfiguring the possibilities by exploiting the opportunities through the delivery of the integrated bundling of product and service [6]. In this vein, DCs owned as a result of collaboration with external parties can be seen as challenging to imitate by competitors [18].

2.2. Sustainability Performance

Seuring and Müller [19] agree that sustainability is a balanced performance of economic, environmental, and social perspectives, while competitiveness is still considered based on satisfying customer needs. Based on this definition, it is important to include all three strands of sustainability in sustainability performance [20]. Environmental performance relies greatly on decreasing the use of hazardous, toxic, or harmful materials and compliance with environmental standards. Increased compliance with environmental standards also provides confirmation of a company's commitment to environmental performance [15]. Implementation of a PSS can also be seen as one solution to reduce the burden on the environment by optimising and prolonging the lifetime of the products [14]. Economic performance refers to financial and marketing performance improvements resulting from sustainability activities that improve the company's current condition, such as an increase in the company's profitability [21] and market share [22]. In this study, economic outcomes are the result of financial advantage gained by providing the PSS and improving environmental performance. The social side is sustained by achieving the economic aspects and ensuring that the economic activities do not cause any social harm [22]. For example, part of the social aspect of sustainability performance is to ensure the availability of employment in the surrounding community [23] and to increase the quality of life for employees and their families by improving employee health and safety [24].

2.3. Structuring PSS SC Capabilities to Support Sustainability Performance

PSS delivery cannot be designed as merely the addition of a service element to the product. It requires the integration of the manufacturer and service partners' SC capabilities to create a collaboration of SC capabilities [8,25]. This integration forms a network of SC capabilities that play an important part in delivering the PSS [26]. Beske et al. [10] identified five SC capabilities that represent the SC capabilities and emphasise the product life cycle concept to explain their impact on sustainability performance (SP): collaboration (CO), knowledge assessment (KA), partner development (PD), reflexive control (REF), and re-conceptualisation (REC). In addition, Kindström et al. [6] introduced innovative service development (ISD), which represents the PSS SC capabilities to complement the proposed model. Likewise, sustainable product–service capability (SPSC) is defined as the capability of designing and using natural resources for manufacturing and service by creating an integrated bundling of product and service, which has been designed to be a powerful tool for developing a more sustainable solution [14]. SPSC is also key determinant for sustainability concerns; hence, it is included in the PSS SC capabilities.

2.3.1. Sustainable Product–Service Capability

Sustainable product–service capability is defined as the capability of designing and using natural resources for manufacturing and service, by creating an integrated bundle of product and service, which has been designed to be a powerful tool for developing a more sustainable solution (economically, socially, and environmentally sustainable) [14]. To support a sustainable product–service capability, manufacturers develop both products and services by establishing collaborative arrangements with their service partners and working together in a network to provide the PSS [14]. Sustainable product capability can be categorised into four stages following the product life cycle concept, namely product design and development, the manufacturing process, supply chain management, and product end of life management [15]. The negative environmental impact resulting from the production processes, consumption, and disposal is a consequence of product design decisions [27]. This implies that sustainable product design can positively affect sustainability performance, especially environmental performance [15]. Capabilities related to reducing waste by reworking and recycling, or prolonging the service life of the products, also positively affect environmental performance [28]. Likewise, any potential pollution prevention will lead to cost reduction and increased profit [29–31]. Furthermore, according to Zhu and Sarkis [32], practising a sustainable supply chain creates benefits for the company with higher innovation and value creation leading to higher profitability. In general, a focus on environmental performance promotes better working conditions and consequently increases worker motivation and productivity, leading to a better economic performance. As a result, the firm can afford to improve the welfare of its employees [22], expand the business, and create more employment in the community [23]. Sustainable product capability has been empirically proven to enhance sustainability performance [15]. Hence, based on the above arguments, the following hypothesis is developed:

Hypothesis 1 (H_1). *Sustainable product–service capability positively affects sustainability performance.*

2.3.2. Innovative Service Delivery

Innovative service delivery is defined as an inherently dynamic process, seeking to identify and exploit the benefits of service innovation, by offering a bundle product–service solution to fulfil customer needs [6]. Customer-linked service, the service delivery process, and the service system arrangement are three capabilities related to innovative service delivery [6]. Hence, the operationalisation of innovative service delivery includes improving service quality [4], on-time service delivery [33], and providing technical expertise on maintenance and repair [8] as well as for the management of matching uncertain demand with available capacity [33] and improving service management facilities [4].

The product's life span can be prolonged using service maintenance and repair or by providing technical consulting and an extended product warranty as part of the innovative service delivery offerings [8]. Activities such as maintenance and repair simultaneously reduce the negative impact on the environment [34] and prolong the service life of products. Garetti and Taisch [14] developed a conceptual model of innovative service delivery to improve the sustainable product–service capability. However, the study of Garetti and Taisch [14] was at the stage of conceptual research, which suggests that it is necessary to test empirically the relationship between innovative service delivery and sustainable product–service capability in the Indonesian context. At the same time, activities such as maintenance and repair have the possibility to reduce any negative impact on the environment [35]. Furthermore, many jobs are created within the social community because services across a network require workers to carry out service delivery [36]. Accordingly, we can assume that innovative service delivery positively affects sustainability performance. Hence, the above arguments support the following hypotheses:

Hypothesis 2 (H_2). Innovative service delivery positively affects sustainable product–service capability.

Hypothesis 3 (H_3). Innovative service delivery positively affects sustainability performance.

2.3.3. Reflexive Control

Reflexive control is defined as the capability to gather and share the information needed and to monitor and evaluate the performance of the SC; it aims to control SC functionality [12]. Controlling the SC is essential as part of transparency, information sharing for monitoring purposes, and partner control [10]. Mandal et al. [37] and Zhu and Sarkis [32] confirmed that SC controlling activities, such as monitoring and ISO 14001 certification, have been positively associated with improved environmental performance. Likewise, controlling and auditing using standards and certifications becomes the driver of sustainable product–service capability [38,39].

A closed-loop SC is a way of re-conceptualising the SC. Domains relevant to the closed-loop SC include PSS activities such as maintenance and advice on the efficient use, production, and recovery processes such as repair, recycling, remanufacturing, and refurbishment of the product [40]. Those activities require many stakeholders in the SC to actively participate in the closed-loop SC, and, hence, all those activities need to be controlled throughout the product's life cycle [41]. Likewise, Coenen et al. [42] and Ndubisi et al. [43] also found that controlling the process of re-conceptualisation was essential. In relation to the activities of service and maintenance, there is a need for standards and certifications to evaluate the service partners' performance. In addition, the capability to follow environment regulations should also be evaluated using standards and certifications [10]. Hence, the above arguments support the following hypotheses of this study:

Hypothesis 4 (H_4). Reflexive control positively affects sustainable product–service capability.

Hypothesis 5 (H_5). Reflexive control positively affects re-conceptualisation.

2.3.4. Re-Conceptualisation

Re-conceptualisation is defined as the capability to change SC-wide business models and is a key component in achieving a sustainable SC [44]. In these circumstances, the stronger partner needs to guide the smaller partners in terms of sustainability performance goals [10]. A closed-loop SC is a way of re-conceptualising the SC [44]. A closed-loop SC is defined as those activities related to refurbishing and remanufacturing products [45,46], which may involve reducing, reusing, and recycling [45,47]. A product's take-back program, refurbished products, maintenance, and advice on efficient use are all parts of closed-loop SC activities [42]. The closed-loop SC becomes an enabler of sustainable product–service performance [38,39], which suggests the requirement for investigating the relationship between re-conceptualisation and sustainable product–service capability. Based on the above arguments, the following hypothesis is developed:

Hypothesis 6 (H_6). Re-conceptualisation positively affects sustainable product–service capability.

2.3.5. Knowledge Assessment

Knowledge assessment is defined as the capability to access and understand the knowledge coming from the strongest partner in the SC [11]. Each partner in the SC should develop its capabilities by accessing and understanding the capabilities of the other partners and use these for the benefit of the entire SC [17]. In this study, the service partners characterised as small partners are usually the weakest in the SC and do not have the capability to evaluate the knowledge available. Hence, the operationalisation of this construct is mostly based on knowledge sharing. Knowledge assessment is important for promoting the Triple Bottom Line concept [46,48]. Educating all stakeholders in the SC about sharing responsibilities on product and sustainability issues is the way to improve sustainable product capability [38].

An integrated knowledge of products and services is crucial for the development of service delivery so that the knowledge assessment in these areas can be accessible to all stakeholders in the SC [4]. These knowledge assessment processes include the learning necessary to develop service delivery [7] and a knowledge assessment about the market and customers, which helps to create insight into customer needs [6]. Moreover, knowledge assessment is a key function of the partners' learning in the SC to innovate new ideas for delivering the product [13]. Several studies have already confirmed empirically that knowledge assessment positively affects innovativeness [49,50].

In the knowledge-intensive industry, it is essential that knowledge can be easily accessed and gained by suppliers [11]. Knowledge can be shared and developed using partner development programs [10]. Increasing the level of knowledge assessment enhances the suppliers' knowledge and expertise, leading to improved partner development [51]. Thus, partner development can be improved by enhancing the knowledge assessment [52]. Hence, the above arguments support the following hypotheses of this study:

Hypothesis 7 (H_7). Knowledge assessment positively affects sustainable product–service capability.

Hypothesis 8 (H_8). Knowledge assessment positively affects innovative service delivery.

Hypothesis 9 (H_9). Knowledge assessment positively affects partner development.

2.3.6. Partner Development

Partner development refers to the capability to enhance the partners' capabilities, and this includes improving their sustainability performance to be able to enhance harmony across the SC [19]. SC goals can only be achieved by developing the SC capabilities of all stakeholder partners, including the weakest partners [10]. From a sustainable SC perspective, strong partners should help weaker partners pursue sustainability [19]. Agi and Nishant [48] confirmed that partner development is a significant requirement to achieve sustainability. Likewise, partner development becomes an enabler for achieving sustainable product–service capability [53]. Gunasekaran and Spalanzani [39] further emphasise that educating partners about their roles in the SC makes a significant contribution to improving sustainable product–service capability. However, the study of Gunasekaran and Spalanzani [39] was at the stage of conceptual research, which suggests that it is necessary to test empirically the relationship between partner development and sustainable product–service capability.

Although manufacturers are the owners of the product and technical knowledge, they do not have the capabilities to deliver the service by themselves. Instead, the manufacturer utilises a vertical service partners network for developing service delivery offerings [21]. Long-term collaboration with service partners is the best choice to deliver the PSS offerings [2]. Partner development assists a network of service partners by continuously improving their knowledge, by providing a variety of training related to product and innovative service delivery, and by strengthening their technical expertise for the products' service and maintenance [6,8]. Agarwal and Selen [49] were of the opinion that improved training as part of partner development could increase service innovation. Based on the above arguments, the following hypotheses are developed:

Hypothesis 10 (H_{10}). Partner development positively affects sustainable product–service capability.

Hypothesis 11 (H_{11}). Partner development positively affects innovative service delivery.

2.3.7. Collaboration

Collaboration is defined as a partnership activity that creates new resources where two or more parties jointly work together to achieve a mutual benefit [11,54]. As this study focuses on the SC capabilities required to deliver a PSS, the integration of product and service activities is important. Customer needs and expectations are also crucial for this collaboration [54,55]. Hence, the operationalisation of collaboration includes long-term relationships [33], joint product–service planning [10], information technology integration to share information [33], logistics integration [37], and sharing demand forecasting [56]. Collaboration is a noteworthy driver of sustainable product–service capability [53], which suggests the importance of testing the relationship between collaboration and sustainable product–service capability.

Many studies have suggested that collaboration encourages collaborative behaviour, mutual creativity, and innovation [57]. This will, in turn, have an impact on building an innovative service offering [49]. At the same time, working collaboratively within the network will strengthen the service delivery performance [58]. In fact, the establishment of partnerships and networking is paramount in accomplishing excellent service delivery [59].

Previous studies found that collaboration enables companies to assess knowledge within the SC [58,60]. By collaborating with their service partners, manufacturers can increase access to knowledge, leading to an overall improvement in the knowledge assessment [50]. The higher the level of collaboration between manufacturers and service partners, the better the level of knowledge assessment [61]. Further, Maheshwari et al. [62] emphasised that building a reliable partner development process requires the commitment of all stakeholders in the SC, both manufacturers and service partners. Hence, Krause and Ellram [63] concluded that long-term collaboration with shared information and communication also improves partner development.

Chkanikova and Sroufe [64] found that improved collaboration within the SC network considerably affects reflexive control. Their possible explanation was that collaborative efforts made stakeholders in the SC address their joint interests and possible conflicts and interests and so establish reflexive control over each other [64]. By working together, manufacturers and service partners can establish the requirements and a commitment to achieving the SC goals even before monitoring commences [65]. While reflexive control can be considered the process to control and monitor a SC's performance with the aim of retaining and promoting SC functionality [10,66,67], collaboration is a good precursor to have before monitoring is undertaken. Hence, the above arguments support the following hypotheses of this study:

Hypothesis 12 (H_{12}). Collaboration positively affects sustainable product–service capability.

Hypothesis 13 (H_{13}). Collaboration positively affects innovative service delivery.

Hypothesis 14 (H_{14}). Collaboration positively affects knowledge assessment.

Hypothesis 15 (H_{15}). Collaboration positively affects partner development.

Hypothesis 16 (H_{16}). Collaboration positively affects reflexive control.

3. Methods

This section provides an overview of the quantitative data analysis completed in this study including instrument development, data collection, and preliminary data analysis.

3.1. Instrument Development

To test the proposed hypotheses, this study employed a quantitative approach using a questionnaire to collect data from the Indonesian motorcycle service partners. A systematic process to develop the survey instrument was performed as measurement items of the eight constructs in the proposed framework. The questionnaire consisted of two sections. The first section asked ten questions regarding the demographic information about the companies and participants. The second section consisted of 41 questions measuring the PSS SC capabilities: CO (6 items), KA (5 items), PD (5 items), REC (5 items), REF (4 items), ISD (5 items), SPSC (5 items), and SP (6 items) using six rating and Likert scales.

The methodology for survey development is organised into five stages [68]. The first stage is to specify the domains of each construct. This stage should provide information on the importance of the construct, its conceptual definition, and a list of dimensions that represent the elements of the construct. This required an intensive literature review to form eight domains of a construct [68]. The second stage, for developing better measures, is to generate items that capture the domain as specified [69]. In this study, an initial pool of 41 items from 8 constructs was created, can be seen in Section 4.1. The third stage is pre-testing; five academic experts were recruited for this study. An adjustment to the instrument, such as changes to the terminology, modifies sentences, adds new items, and deletes irrelevant items to authorize the pre-test responses. In this study, there were no added new items or deleted irrelevant items so the initial pool of 41 items was retained. In the fourth step, a pilot test was undertaken to purify the instrument [68]. Ten persons from the official motorcycle service partners were asked to fill out the instrument. The results confirmed that the manufacturer term should be replaced by the main dealers as intermediaries because the main dealers acted as the manufacturer's representative to provide the PSS SC capabilities to the service partners. After the adjustment about the term was applied, the initial 41 items were still retained. In the final step, an interrater agreement survey was completed, where 20 heads of service partners and academic experts who have expertise in the SC field were asked to participate [68]. The five-point Likert scale was used to evaluate the relevance of the variable items (i.e., 0 = not relevant, 1 = minimally relevant, 2 = moderately relevant, 3 = substantially relevant, 4 = extremely relevant). There were three criteria suggested for dropping items: (1) drop items when their 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 [70]. According to the three criteria for dropping items discussed above, no items were removed, and the initial 41 items were retained in the final questionnaire (Appendix A). The results showed a mean value of $3.05 - 3.70$, all $p -$ values < 0.05, and a power of $0.80 - 1$. Hence, no items were removed, and 41 items were retained in the final questionnaire.

3.2. Data Collection and Preliminary Data Analysis

Data used in this research were collected from Indonesian motorcycle official service partners between November 2019 and June 2020. In this study, the sampling frame consisted of the population of official motorcycle service partners in Indonesia. The population was established by the researcher by collecting service partner data from the websites of the five motorcycle brands, resulting in a sampling frame of about 6800 service partners. Simple random sampling was used to ensure generalisation of the results. The participants were managers of the official service partners of motorcycle manufacturers in Indonesia. The inclusion criterion for the managers of the motorcycle manufacturers' official service partners in Indonesia was having working experience in this field for at least one year.

The questionnaire was distributed to 1300 motorcycle official service partners in Indonesia (1050 online and 250 by mail). Participants were asked to respond to the survey, including ten questions on demography and 41 context questions asking about the relationship between the PSS SC capabilities and sustainability performance. The mail survey was conducted only in the first wave without reminders, but an online survey was conducted in three waves with first and second reminders to obtain a high survey response rate. For the first wave, both the online survey and mail surveys were distributed, and 474 responses were received (452 from the online survey and 22 from the mail survey). The researcher then sent the first email reminder. The second wave of data collection received 168 responses. In the final phase, a second email reminder was sent, and in the third wave of data collection, another 86 responses were received. Overall, 728 responses were obtained both from the online and mail surveys (56% response rate). There were 281 responses that only answered the online survey's demographic questions, so these responses could not be used or analysed. After being reduced by incomplete responses, a total of 447 responses were recorded for analysis.

The sample's demographic profile is shown in Table 1, which indicates that 87.5 per cent are service partners with fewer than 10 employees. This was predictable since most service partners are categorised as small–medium enterprises. The majority of the surveyed motorcycle service partners were based in Java (65.5 per cent), followed by Sumatera (14.1 per cent), Sulawesi (7.2 per cent), Kalimantan (5.6 per cent), Bali-NT (5.6 per cent), and Maluku-Papua (2 per cent). The sampling was consistent with the Indonesian government's census in 2010, which revealed that 57.5 per cent of the population lived in Java [71]. Furthermore, many service partners have collaborated with the manufacturers for more than ten years (63.3 per cent).

Table 1. Demographic profile of participants.

Key Demographic	Frequency (*n* = 447)	Percentage (%)
Location		
Java	293	65.5
Bali-NT	25	5.6
Sumatera	63	14.1
Sulawesi	32	7.2
Kalimantan	25	5.6
Maluku-Papua	9	2.0
No of employees		
less than 10	391	87.5
10–30	38	8.5
31–50	4	0.9
51–70	3	0.7
more than 70	11	2.5
Company Operation		
0–5	76	17.0
6–10	88	19.7
11–15	130	29.1
More than 15	153	34.2

To check for non-response bias, Levene's test for equality of variance and a t-test for the equality of means were performed to measure statistical significance between the early and late waves. The early wave included those participants who participated in the first wave (n = 226). The late wave included those who participated later in the second and third waves (n = 221). The results showed the early and late waves were not statistically significant, with p-values greater than 0.05 for the six constructs. These results confirmed no differences in the means and variation between the early and late waves. Hence, non-response bias was not an issue in this study.

4. Results

This section presents the results of the study. This section covers the validity tests, assessment of construct reliability, common method bias assessment, assessment of the structural model, and results for the hypotheses.

4.1. Validity Tests

Exploratory factor analysis (EFA) and Confirmatory Factor Analysis (CFA) were employed as validity tests. Initially, the EFA was utilised using SPSS version 26 to assess the dimensionality of the scale, followed by running the CFA in AMOS version 26 to look at the convergent validity, discriminant validity, and factorial validity. EFA with maximum likelihood extraction and promax rotation was utilised to verify the scale's dimensionality. For this study, the EFA needed to be run separately for eight constructs to test the conceptual model given in Section 2. The factorability of the data was tested using the Kaiser's criterion (eigenvalue > 1) and parallel analysis to investigate the number of factors that can be extracted [72]. Eight constructs produced a one-factor solution that explained 53.4 to 71.1 per cent of the variance, so the eight constructs were considered valid by Tinsley and Tinsley [73] with factor loading between 0.435 and 0.869, which is considered valid for factor loading above 0.4.

Convergent validity is the degree of agreement for a set of indicators that measure the same construct. The convergent validity test consisted of three steps: first, calculate the chi-squared values of each construct, and second, if the chi-squared rejects a factor at $p < 0.01$, then utilise the modification indices to identify common factors among items. As a precaution, the items which have a low validity should be dropped (i.e., dropped from the validity index of the interrater agreement). This process resulted in 8 constructs and 35 items. It dropped 6 items: CO4, CO6, PD4, REC5, ISD2, and SPSC1. These findings are confirmed as evidence of convergent validity [74] with the goodness of fit indices cut-off values: $p > 0.01$, norm $\chi^2 \leq 2$, RMSEA < 0.05, SRMR < 0.07, CFI > 0.96, and TLI > 0.95. Furthermore, the average variance extract (AVE) for all constructs was greater than 0.5 (ranging from 0.61 to 0.71) with standard factor loading (SFL) of all items being greater than 0.5 (ranging from 0.50 to 0.87), can be seen in Section 4.1. These findings are confirmed as evidence of convergent validity [75].

The discriminant validity assessment has the purpose of guaranteeing that the construct has the strongest relationships with its items and not with any other construct in the structural model [75]. Discriminant validity among the eight constructs in this study was achieved as the value of AVE for each construct was greater than the value of the square correlation between the respective construct and the other constructs (Table 2).

Table 2. AVE and square inter-construct correlation of discriminant validity.

Construct	ISD	KA	PD	CO	SPSC	REF	REC	SP
ISD								
KA	0.404	0.711						
PD	0.389	0.551	0.689					
CO	0.267	0.548	0.456	0.641				
SPSC	0.129	0.209	0.272	0.228	0.549			
REF	0.068	0.170	0.141	0.186	0.458	0.671		
REC	0.056	0.132	0.123	0.147	0.410	0.510	0.626	
SP	0.187	0.108	0.176	0.100	0.503	0.246	0.247	0.679

Finally, the factorial validity examines whether a set of latent variables demonstrate an underlying pattern by evaluating the fit statistics of the full measurement model. The results confirmed a good fit of the measurement model that supported factorial validity of the measurement model (normed $\chi^2 = 1.481$, SRMR = 0.033, RMSEA = 0.023, CFI = 0.976, and TLI = 0.974).

4.2. Assessment of Construct Reliability

Supporting the fact that the measurement model of the constructs in this study is congeneric, coefficient H is considered the best measurement of reliability for this case [76]. The results confirmed that the scales were reliable as H > 0.8 for all constructs, ranging from 0.859 to 0.926. In addition, the values of Construct Reliability (CR) and Cronbach's alpha were greater than 0.7, which confirmed the scale reliability [75]. CR in this study ranged from 0.826 to 0.927, and Cronbach's alpha ranged from 0.798 to 0.927. These results reaffirmed that the scales in this study were reliable. The value of H, CR, and Cronbach's alpha can be seen in Table 3.

Table 3. Construct and scale items.

Construct and Scale Items	Source of Items	Factor Loading
Collaboration is defined as a partnership activity that creates new resources where two or more parties jointly work together to achieve a mutual benefit, H = 0.885, alpha = 0.873, CR = 0.826		
Work jointly on the product–service systems planning—CO1	[10]	0.83
Maintain a long-term collaborative relationship based on mutual trust—CO2	[33]	0.81
Logistics activities are well integrated—CO3	[37]	0.71
The same information technology platform that can share information—CO4 (OMITTED)	[33]	
Share the measurement of customer satisfaction and expectation—CO5	[55]	0.85
Share demand forecasting and planning—CO6 (OMITTED)	[56]	
Knowledge assessment is the capability to access and understand the knowledge from the strongest partners in the SC, H = 0.926, alpha = 0.925, CR = 0.925		
Have access to knowledge and technical expertise of the product—KA1	[17]	0.86
Enhances our knowledge about the benefit of sustainability—KA2	[10]	0.86
Provides us with knowledge of information technology to provide the bundling of product and service offerings—KA3	[10]	0.86
Learn about customers' needs and requirements—KA4	[6]	0.81
Learn about innovations related to the product–service bundling—KA5	[13]	0.85
Partner development is defined as the capability to enhance the capabilities of service partners including their sustainability responsibility to be able to enhance harmony across the supply chain, H = 0.901, alpha = 0.897, CR = 0.899		
Capability to continuously improve our knowledge—PD1	[10]	0.81
Provides us with a variety of training courses to increase our capabilities—PD2	[33]	0.87
Provides partner development programs to learn about the product–service systems—PD3	[4]	0.84
Enhances service partner's capabilities to achieve the sustainability goal in our SC—PD4 (OMITTED)	[10]	
Strengthens our technical expertise related to the product's service and maintenance—PD5	[8].	0.80
Reflexive Control is defined as the capability to gather, share information, and monitor and evaluate the performance of an SC, H = 0.893, alpha = 0.891, CR = 0.891		
Shares information to us about product–service offerings—REF1	[55]	0.79
Our main dealers and we have systems for monitoring and evaluating SC performance—REF2	[37]	0.83
Our main dealer evaluates our performance by its standards—REF3	[10]	0.83
We are capable of fulfilling certifications required by our main dealer for evaluating our performance—REF4	[10]	0.82
Re-conceptualisation is defined as the capability to change what the SC does by moving toward closed-loop systems and servicing, H = 0.873, alpha = 0.870, CR = 0.868		
Capability to follow the environment regulation determined by the Indonesian motorcycle industry association—REC1	[47]	0.80
Offer a product take-back program—REC2	[42]	0.73
Advise customers on how to use our products in an energy-efficient mannee—REC3	New	0.82
Suggest customers to regularly maintain their products—REC4	New	0.81
Offer refurbished motorcycles—REC5 (OMITTED)	[45]	
Innovative service deliveryis defined as an inherently dynamic process, seeking to identify and exploit the benefits of service innovation, by offering a bundle product–service solution to fulfil customer needs, H = 0.900, alpha = 0.893, CR = 0.888		
Improve service quality to fulfill customer needs—ISD1	[4]	0.73
Reliable to deliver our service on time—ISD2 (OMITTED)	[6]	
Proficient to deliver an innovative bundling of product–service particularly in providing maintenance and repair services—ISD3	[8]	0.84
Manage service capacity with uncertain demand—ISD4	[33]	0.86
Always improve service management facilities—ISD5	[4]	0.85
Sustainable product–service capability is defined as the capability of designing and using natural resources for manufacturing and service, by creating an integrated bundle of product and service, which have been designed to be a powerful tool for developing a more sustainable solution, H = 0.859, alpha = 0.826, CR = 0.798		
Our product design prolongs the life of materials—SPSC1 (OMITTED)	[15]	

Table 3. *Cont.*

Construct and Scale Items	Source of Items	Factor Loading
Our product design enables repair, rework, and recycling—SPSC2	[45]	0.70
Our product design facilitates disassembly—SPSC3	[15]	0.83
Adhere to environmentally related programmes, standards, and regulations—SPSC4	[15]	0.87
Prolong the service life of products by providing maintenance and support to customers—SPSC5	[15]	0.50
Sustainability performance is defined as the capability to conduct business with a long-term goal of maintaining the well-being of the economy, environment, and society, H = 0.928, alpha = 0.927, CR = 0.927		
Provide a bundle of product and service to increase our profit—SP1	[22]	0.79
Deliver a bundle of product and service that make improvements to our market share—SP2	[22]	0.84
Improve the opportunities of the surrounding community with respect to employment—SP3	[23]	0.82
Improve the occupational health and safety of employees—SP4	[24]	0.82
Improve our compliance with environmental standards—SP5	[22]	0.86
Decrease the use of hazardous, toxic, and harmful materials in manufacturing our products—SP6	[23]	0.81

4.3. Common Method Bias Assessment

Assessment of Common Method Variance (CMV) is essential when independent and dependent variables are measured using the same participants simultaneously [77]. Initially, Harman's single-factor test was utilised so that all items for all constructs were loaded into one factor to investigate the CMV [78]. The results using the Maximum Likelihood extraction method showed that the AVE was 34.5%, indicating that no CMV exists. For further investigation of the CMV existence in this model, a common latent factor (CLF) was added into the measurement model [79]. This involved simply adding a CLF to all observed items in the CFA model and then computing the difference between the standardised regression weights from this model and the CFA model without the CLF. If the value is smaller than 0.200, then the CMV is not an issue [80]. The results showed that the standardised regression weight value differences between the CFA model with and without the CLF are smaller than 0.200, suggesting that CMV is not an issue in this study. Furthermore, an examination of the fit indices of the original model ($\chi^2 = 0.00$; SRMR = 0.02; RMSEA = 0.03; CFI = 0.98; TLI = 0.98) and of the new model with the added latent variable ($\chi^2 = 0.00$; SRMR = 0.02; RMSEA = 0.03; CFI = 0.98; TLI = 0.97) showed similar results. In summary, the results from Harman's single-factor test [78], CLF, and fit indices have consistently shown that common method bias was not present in this study.

4.4. Assessment of the Structural Model and Results of Hypotheses

The proposed structural model generated a good fit model with normed $\chi^2 = 1.448$; SRMR = 0.030; RMSEA = 0.034; CFI = 0.974; TLI = 0.973. The Bollen–Stine bootstrapping with 2000 random bootstrap samples generated a *p*-value of 0.062, which ensures the fit of the structural model. The model could be considered parsimonious as the PCFI value was 0.91.

The results of the hypotheses tests are summarised in Figure 1 and Table 4. The results show that SPSC positively affects SP ($\beta = 0.64$, $p < 0.001$), supporting H_1. There is insufficient evidence to support hypothesis H_2 as the relationship between ISD and SPSC is insignificant ($\beta = 0.06$, $p = 0.42$). However, hypothesis H_3 of ISD on SP is supported by the path coefficient (β) of 0.19 and $p < 0.001$. Furthermore, H_4 is supported by evidence that REF positively affects SPSC ($\beta = 0.38$, $p < 0.001$). Likewise, H_5 is supported by evidence that REF positively affects REC ($\beta = 0.72$, $p < 0.001$). REC positively affects SPSC (H_6), which was shown to be statistically significant at $\beta = 0.29$ and $p < 0.001$. H_7 is the path postulated by KA and SPSC, which is found to be not statistically significant. However, KA positively affects ISD as postulated in H_8 ($\beta = 0.38$ and $p < 0.001$). The results also show that KA positively affects PD (H_9), which is statistically significant at $p < 0.001$ with $\beta = 0.53$. Likewise, H_{10} posits that PD positively affects SPSC, and this hypothesis is supported by $\beta = 0.29$ and $p < 0.001$. H_{11} theorises that PD positively affects ISD, and the results indicate that this hypothesis is supported at $p < 0.001$ and $\beta = 0.34$. Conversely, the CO path to SPSC (H_{12}) and CO path to ISD (H_{13}) are found to be not statistically significant, indicating that those hypotheses are not supported. CO positively affects KA ($\gamma = 0.75$, $p < 0.001$), supporting H_{14}. H_{15} posits that CO positively affects PD, which is found to be statistically significant at $p < 0.001$ with $\gamma = 0.29$. Finally, for H_{16}, the result shows that CO positively affects REF ($\gamma = 0.46$, $p < 0.001$). The data accounted for 21, 56, 45, 59, 53, and 57 per cent of the variance for REF, KA, ISD, PD, REC, and SPSC, respectively. The results in Figure 1 show 53 per cent of the variance for SP, which is good [81].

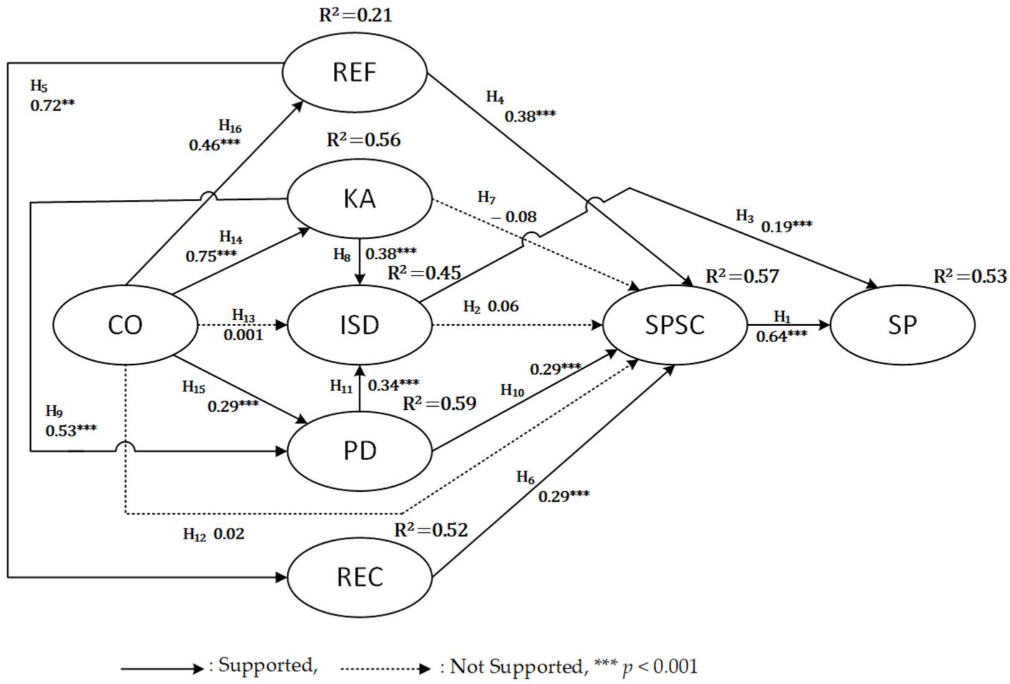

Figure 1. Result of the structural model.

Table 4. Hypotheses and results.

	Hypotheses Path	Estimate	*p*-Value	Results
H_1	SPSC → SP	0.64	$p < 0.001$	supported
H_2	ISD → SPSC	0.06	0.419	not supported
H_3	ISD →SP	0.19	$p < 0.001$	supported
H_4	REF → SPSC	0.38	$p < 0.001$	supported
H_5	REF → REC	0.72	$p < 0.001$	supported
H_6	REC → SPSC	0.29	0.003	supported
H_7	KA → SPSC	−0.08	0.356	not supported
H_8	KA → ISD	0.38	$p < 0.001$	supported
H_9	KA → PD	0.53	0.002	supported
H_{10}	PD → SPSC	0.29	$p < 0.001$	supported
H_{11}	PD → ISD	0.34	$p < 0.001$	supported
H_{12}	CO → SPSC	0.02	0.619	not supported
H_{13}	CO → ISD	0.001	0.998	not supported
H_{14}	CO → KA	0.75	$p < 0.001$	supported
H_{15}	CO → PD	0.29	$p < 0.001$	supported
H_{16}	CO → REF	0.46	$p < 0.001$	supported

5. Discussions and Implications

This section presents the discussion, implications for theory, and implications for practice.

5.1. Discussion

The empirical evidence shows that sustainable product–service capability has a large positive effect on sustainability performance (H_1). This finding is consistent with the evidence from Hanim et al. [15], who found that sustainable product design, sustainable manufacturing process, and sustainable end-of-life management are the components of sustainable product–service capability that essentially improve sustainability performance. Consequently, to support the whole product life cycle, the manufacturers have to collaborate with the service partners to support maintenance and service to prolong a product's end of life. This study further shows that innovative service delivery has a small direct positive effect on sustainability performance, supporting H_3. However, H_2 is not significant, which implies that innovative service delivery does not have a direct impact on sustainable product–service capability. Although innovative service delivery is crucial to the development of a sustainable product–service capability, the impact of a sustainable product–service capability probably depends more on how well the manufacturing partner designs its products to facilitate disassembly and enable repair, rework, and recycling to prolong the life of materials and its adherence to environmentally related programs, standards, and regulations. That is the most likely explanation as to why innovative service delivery does not have a direct impact on sustainable product–service capability. The findings are consistent with Garetti and Taisch [14], who found that innovative service delivery positively affects sustainability performance. The existing literature supports the notion that the practice of innovative service delivery as a bundle of the PSS offerings such as maintenance and service guarantees the proper functioning of the motorcycle and could prolong the product lifespan and, therefore, has the possibility to improve sustainability performance [35]. Having the capability to manage and transform the PSS, especially involving the partnership among manufacturers, main dealers, and service partners for delivering innovative service delivery are the seizing and reconfiguring capabilities of the SC network.

This study further shows that the participants generally perceive that reflexive control has a medium positive impact on sustainable product–service capability (H_4). This outcome supports Bhanot et al. [38] and Moktadir et al. [53], who found that reflexive control was an enabler of sustainable product–service capability. Likewise, this result is consistent with the findings of Liu et al. [82], who emphasised that good monitoring and evaluation systems improve sustainable product–service capability. Furthermore, the results of this study reveal that reflexive control shows a large positive effect of reflexive control on re-conceptualisation (H_5). As expected, this result is consistent with the findings from Accorsi et al. [41], who confirmed that the activity of controlling was required for re-conceptualisation to actually monitor the closed-loop SC. The most likely explanation of the large effect size of reflexive control on re-conceptualisation is similar to those put forward by Beske et al. [10], who found that monitoring, evaluating, and the capability to meet standards and certifications were required as tools to control re-conceptualisation.

This study also reveals that re-conceptualisation has a medium positive effect on sustainable product–service capability (H_6). This finding aligns with that of Pagell and Wu [44], who found that the practice of a closed-loop SC was viewed as a way to re-conceptualise the SC and positively affect sustainable product–service capability. However, there is a considerable difference in the practice of re-conceptualisation between developed countries and less developed countries. In developed countries, part of re-conceptualisation is a formal refurbishment process provided by the Original Equipment Manufacturer. Less developed countries usually do not have recycling facilities. Indeed, the item about offering refurbished motorcycles (REC5) was dropped from the re-conceptualisation construct due to its insignificant factor loading value, and this happened because refurbished motorcycles are not yet offered in the Indonesian motorcycle industry. Indonesia's imposition of environmental standards is less than developed countries as the Indonesian government still gives priority to social issues such as the positive impact of employment provided by the motorcycle industry. The Indonesian government has not yet regulated any requirement for environmental product declarations that include a full life cycle assessment [83], Environmental management systems and sustainability reports are becoming more common in Indonesia, but those certifications are based on a voluntary scheme [83]. Furthermore, the infrastructure to implement a closed-loop SC in Indonesia is currently not economically feasible. However, the current re-conceptualisation activities which support maintenance and service, such as following the environmental regulations and suggesting that customers regularly maintain their product and use it in an energy-efficient manner, can contribute to re-conceptualising the SC. These activities are considered as the seizing and reconfiguring through the partnership to deliver the PSS.

This study further demonstrates that knowledge assessment does not directly affect sustainable product–service capability (H_7). The findings of this study differ from Lorek and Spangenberg [84] and Moktadir et al. [53], who found that knowledge assessment is a driver of sustainable product–service capability. A possible explanation for this is that knowledge assessment does not directly affect sustainable product–service capability as knowledge assessment needs to be transferred in the form of partner development. Thus, this finding is consistent with Beske [11], who reflected that usually knowledge assessment goes hand-in-hand with partner development. Likewise, Bhanot et al. [38] confirmed that knowledge assessment and partner development work closely as enablers of sustainable product–service capability. The results of this study also reveal that knowledge assessment has a medium positive effect on innovative service delivery (H_8). This is consistent with the findings of Ayala et al. [4], who found that knowledge assessment is crucial to improve innovative service delivery. Knowledge becomes an essential source of innovative service delivery development when product technical knowledge is required for maintenance and service purposes [85]. In most cases, the focal companies have more capabilities than the smaller partners, so there is usually a high degree of knowledge to be shared with the service partners [10]. In Indonesia, motorcycle service partners are mostly small and medium enterprises that usually have little knowledge to contribute to the SC network. Hence, they require support from the focal companies that possess greater knowledge and capabilities. Indeed, knowledge assessment has a large effect on partner development (H_9). This is consistent with the findings from Lawson et al. [51], who confirmed that knowledge assessment is positively associated with partner development and has a large effect size (0.55). In order to replicate the explicit knowledge and provide access across company boundaries within the network, knowledge assessment is formalised into more tangible materials that allow more organisations such as service partners to use them. In this case, manufacturers seize the opportunity to share knowledge assessment and partner development with their main dealers and service partners.

This study also supports the medium effect size of partner development on sustainable product–service capability (H_{10}). This finding is in line with the study of Wu [86], who confirmed that partner development had a large effect size (0.64) on sustainable product–service capability. The partner development items in Wu [86]'s construct include partner development evaluation, while in this study, evaluation is assigned to a different construct. Hence, the effect size in this study is different from the effect size in the Wu [86] study. Likewise, Moktadir et al. [53] also confirmed that partner development is an enabler to improve sustainable product–service capability. As small and medium enterprises, the service partners have neither the technical knowledge nor the environmental awareness to improve sustainable product–service capability by themselves. Similarly, partner development has a positive effect on innovative service delivery (H_{11}). This result aligns with the qualitative results from Gebauer et al. [21], who found that it was essential for the focal companies to support their service partner network with technical knowledge assistance. This support delivers a noticeable positive impact on the improvement of innovative service delivery.

Collaboration does not have a direct effect on sustainable product–service capability (H_{12}). This outcome is contrary to previous studies [53,87]. A plausible explanation could be that collaboration might be required as a precursor to knowledge assessment and partner development before having an impact on sustainable product–service capability. This argument aligns with the results from Agi and Nishant [48], who found that knowledge assessment and partner development are essential to promote sustainable product–service capability. Likewise, a previous study confirmed that collaboration is a prerequisite to knowledge assessment and partner development [60]. Similarly, collaboration does not have a direct positive effect on innovative service delivery (H_{13}). This implies that even though collaboration is crucial to develop innovative service delivery capabilities, the impact of innovative service delivery may depend on how well service partners can apply the knowledge assessment and partner development received from the main dealers. This is in line with the result of Wang and Hu [58], who found that collaboration resulted in better absorption of knowledge and partner development in the SC network and finally impacted innovative service delivery. The previous statement is supported by H_{14}, which indicates the participants generally recognise the large positive effect of collaboration on knowledge assessment. This result aligns with the findings of Wang and Hu [58], who also found evidence of a large effect size of collaboration on knowledge assessment because collaboration generates mutual trust and impacts by enhancing access to knowledge assessment. A possible explanation here is that organisations with a higher level of collaboration are more willing to provide access to knowledge assessment [4]. Hence, an arms-length type of collaboration is not an option for a knowledge-intensive industry such as the motorcycle industry. This study also finds a medium positive effect of collaboration on partner development (H_{15}). The findings from this study confirm well the findings of Lo et al. [88], who also found a medium effect size in the relationship between collaboration and partner development. This study further indicated that participants generally recognise the medium positive effect of collaboration on reflexive control (H_{16}). This is consistent with the findings from Green et al. [65], who found evidence of a large positive impact of collaboration on reflexive control. Green et al. [65] used constructs that specifically measured the impact on environmental aspects, while the constructs in this study are concerned with PSSs and sustainability. Therefore, the effect sizes from the two studies are not comparable. A high level of collaboration allows the SC stakeholders to discuss how to implement the controls, which in turn makes the reflexive control well accepted by all members in the SC network [64]. DCs are hard to develop alone. DCs works best by making collaboration among manufacturers, main dealers, and service partners. The findings of this study reveal that collaboration has a positive effect on several construct, meaning that stakeholders in the SC sense and seize the opportunities to reconfigure resources by exploiting the SC network capabilities to develop PSS in order to improve sustainability performance.

5.2. Implications for Theory

This study makes several contributions to research and theory. First, this study contributes to the currently scarce literature on the PSS by integrating the PSS into the SSCM concept to provide a broader perspective of the product life cycle concept within a single framework. Furthermore, it contributes to the existing PSS literature by identifying and further developing the seven PSS SC capabilities: collaboration, knowledge assessment, partner development, reflexive control, re-conceptualisation, innovative service delivery, and sustainable product–service capability, which are needed to improve sustainability performance. This is an important contribution to the body of knowledge as such integration is still nascent in the extant PSS and sustainability SC research. Second, to hypothesise and test the relationships in the conceptual model, this study used dynamic capabilities as an underpinning theory. Thus, this research contributes by extending the use of dynamic capabilities theory by applying it to the PSS and SSCM areas. This study shows empirically how dynamic capabilities fit well to the specific application of investigating the relationship between the PSS SC capabilities and sustainability performance. This study contributes to theory by corroborating that combining theories and concepts such as dynamic capabilities, SSCM, and PSS is fit for use in investigating the relationship between the PSS SC capabilities and sustainability performance. Third, this research has developed and validated survey instruments by defining the constructs and developing measurement items. Most importantly, it has examined the standard loadings of the items within the PSS SC capabilities to determine the relative importance of each SC capability for increasing sustainability performance. The rigorous process of developing the validated survey instrument in this study should make this instrument reliable to use in future research which shares similar characteristics and topics. Furthermore, future studies can benefit from the existing relationships found in the structural model and can extend and develop the current model as required. Finally, using the data collected from the Indonesian motorcycle industry, this research has empirically tested a conceptual model for investigating the relationship between the PSS SC capabilities and sustainability performance in the context of a developing country. Such efforts contribute to the literature by finding that there are considerable differences between developed and developing countries. Most PSS research comes from developed countries and so may not be applicable to developing countries. Again, this is a substantial theoretical contribution to the scarce PSS and sustainability SC research in developing countries.

5.3. Implications for Practice

This study aims to provide insights for managers and policymakers on how the PSS SC capabilities affect sustainability performance, which should help practitioners in the motorcycle industry and policymakers better understand the current situation and how they might improve it. First, motorcycle practitioners can use the measurement items in this study to determine and evaluate the current state of their PSS SC capabilities. From there, motorcycle practitioners can identify any current areas of weakness and formulate strategies to address those weaknesses. They can also utilise the standard loadings of the items to recognise the relative importance of each SC capability for improving sustainability performance. This can help motorcycle practitioners to organise and prioritise their strategies in order to achieve their goals. In this way, motorcycle practitioners can better judge how to use the various PSS SC capabilities to improve their sustainability performance. Second, manufacturers and main dealers must focus on developing and maintaining collaboration with the network of service partners. The manufacturers, as the initiator of the partnership with the service network, should develop strategies for evaluating the current state of the collaboration and how to create more value and improve long-term collaboration with the service partners in the future. A range of possible support and communication channels for service partners, such as direct or hot phone lines and direct onsite assistance, should be developed to support this collaboration as the service partners are the weakest parties in the SC. Other suggested examples are using the same IT platform for sharing information and communication, face-to-face meetings for problem solving, regular meetings, and email and phone support. Because of the considerable gap between the big and small players in terms of market share, the smaller manufacturers should develop strategies for attracting new service partners to their PSS network. Finally, due to the absence of a formal recycling sector, almost all recycling processes in Indonesia rely on the informal sector. As micro- and small-scale businesses, their operations are sometimes damaging and cause harm to the environment. However, they are also highly productive in managing waste problems that are not solved by the formal sector. It is considered counter-productive to remove the existing informal recycling sector. The recommended option would be to assist the motorcycle industry in collaborating with the informal sector so that they manage recovery and recycling operations together.

6. Conclusions and Future Research

Using Dynamic Capabilities, this study has comprehensively investigated seven PSS SC capabilities: collaboration, knowledge assessment, partner development, reflexive control, innovative service delivery, re-conceptualisation, and sustainable product–service capability. The findings confirmed that innovative service delivery and sustainable product–service capability positively affect sustainability performance, whereas partner development, reflexive control and re-conceptualisation positively affect sustainable product–service capability. Further, collaboration and knowledge assessment do not directly affect sustainability performance. Using the Indonesian motorcycle industry as a context, data were collected from 447 motorcycle service partners for analysis using structural equation modelling to test postulated hypotheses. The findings reveal that innovative service delivery and sustainable product–service capability impact directly on sustainability performance, whereas partner development, reflexive control, and re-conceptualisation have direct impacts on sustainable product–service capability. Collaboration and knowledge assessment are important prerequisites for other PSS SC capabilities and do not directly impact sustainability performance.

Nevertheless, this research is subject to several limitations that could also be seen as directions for future research. First, the scope of this study is limited to a specific industry (motorcycles) in a defined geographical area (Indonesia) to make the study feasible. Therefore, further research could apply the methods used and the resulting framework to different industries and a broader geographical scope to examine whether the identified capabilities still apply under different conditions. Future studies might conduct a cross-countries and/or cross-industries study to deliver wider generalisability for the insights in the framework. Second, this research focused on collecting data from service partners' points of view. Further research should collect data from other suppliers in the SC, such as the raw materials and spare parts suppliers, to verify the impact of their PSS SC capabilities on sustainability performance. Likewise, collecting data on customers could lead to a better understanding of customer roles and expectations in the network. Third, this research model has successfully demonstrated 53 per cent of the variance in sustainability performance. This becomes a limitation of this study because not all the PSS SC capabilities directly affect sustainability performance. Further research should investigate the possibility that collaboration, knowledge assessment, partner development, reflexive control, innovative service delivery, re-conceptualisation, and sustainable product–service capability have a direct effect on sustainability performance that could increase the coefficient of determination in the model. This study did not include the contributions of raw material suppliers and third-party logistic suppliers for distribution who may have capabilities to support sustainability performance. Adding these factors in future research might make it possible to increase the coefficient of determination of the model.

Finally, future research should identify other moderating factors, both internal and external, which may influence the relationship between PSS SC capabilities and sustainability performance. It would be interesting to examine the impact of service partners' duration of collaboration (short versus long), technological capability (low versus high), geographical condition (remote versus city), and different cultural factors to observe their impact on the transfer of capabilities to achieve a goal in this framework. Future studies could add those factors into their research to counter a possible weakness of this study.

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Institutional Review Board Statement: The study was approved by the BCHEAN (or Ethics Committee) of the Royal Melbourne Institute of Technology (21895 and 28 February 2019) for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Questionnaire

Do you consent to take part in this survey? ☐Yes ☐No

Selecting "YES" means that you consent to take part in this survey. The data you provide will be only used for research purposes. The research outcomes and results will be published in the thesis, academic journals, and conference papers. All responses are anonymous, so complete confidentiality is provided as part of the data collection process. Upon completion of this research, a summary of the findings can be sent to participating companies. If you would like to receive a copy of the study summary report, please contact the researcher via email: dian.dewi@rmit.edu.au.

How long is your working experience as manager in the official service partner of the Indonesian motorcycle?

☒Less than 1 year ☐More than 1 year

If you have experience more than 1 year as manager in the official service partner of the Indonesian motorcycle industry, you can proceed to complete the questionnaire.

Appendix A.1. Background Information about the Company and Participant

Please respond to the following questions by ticking (can be more than one) the choice that best describes your company.

(Q1) Which motorcycle company do you represent?

☒Honda ☐Yamaha ☐Kawasaki ☐Suzuki ☐TVS ☐Others

(Q2) Where is your company located?

☐Java ☐Sumatera ☐Sulawesi ☐Bali-Nusa Tenggara ☐Kalimantan ☐Maluku-Papua

(Q3) How long has your company been operating?

☒0–5 years ☐6–10 years ☐11–15 years ☐More than 15 years

(Q4) Approximately how many permanent employees work in your company (service division only)?

☐1–10 ☐11–30 ☐31–50 ☐51–70 ☒More than 70

(Q5) What is your position in this company?

☐Head of Branch ☐Manager ☐Head of Service ☐Head of Unit ☐Owner ☐Others

(Q6) How many years of experience do you have in the motorcycle industry?

☐1–5 years ☐6–10 years ☐11–15 years ☐More than 15 years

(Q7) How many years of experience do you have in this current position?

☐1–5 years ☐6–10 years ☐11–15 years ☒More than 15 years

(Q8) Please indicate your gender

☐Male ☐Female ☐Prefer not to say

(Q9) Please indicate your age range

☐25–35 years ☐36–45 years ☐46–55 years ☐56–65 years ☐More than 65 years

(Q10) What is your highest education qualification?

☐Postgraduate ☐Bachelor ☐ Diploma ☐ High school ☐ Below high school

Appendix A.2. Supply Chain Capabilities and Sustainability Performance

The set of questions in this section is intended to assess sustainability performance and your company's supply chain capabilities. Please indicate the extent of your company's supply chain capabilities to the appropriate column by circling your answer, (0 = not at all, 1 = a small extent, 2 = some extent, 3 = a moderate extent, 4 = a great extent, and 5 = a very great extent).

We have access to our main dealer's knowledge and technical expertise of the product	0	1	2	3	4	5
Our main dealer enhances our knowledge about the benefit of sustainability	0	1	2	3	4	5
Our main dealer provides us with knowledge of information technology to provide the bundle of product and service offerings	0	1	2	3	4	5
We learn about customers' needs and requirements from our main dealer	0	1	2	3	4	5
We learn about innovations related to the product–service bundling from our main dealer	0	1	2	3	4	5
Our main dealer has the capability to continuously improve our knowledge	0	1	2	3	4	5
Our main dealer provides us with a variety of training courses to increase our capabilities	0	1	2	3	4	5
Our main dealer provides partner development programs to learn about the product–service systems	0	1	2	3	4	5
Our main dealer enhances service partner's capabilities to achieve the sustainability goal in our supply chain	0	1	2	3	4	5
Our main dealer strengthens our technical expertise related to the product's service and maintenance	0	1	2	3	4	5
We work jointly on the product–service systems planning with our main dealer	0	1	2	3	4	5
We maintain a long-term collaborative relationship with main dealer based on mutual trust	0	1	2	3	4	5
Our logistics activities are well integrated with the main dealer logistic activities	0	1	2	3	4	5
We have the same information technology platform with our main dealer that can share information	0	1	2	3	4	5
We share the measurement of customer satisfaction and expectation with our main dealer	0	1	2	3	4	5
We share demand forecasting and planning with our main dealer	0	1	2	3	4	5
Our product design prolongs the life of materials	0	1	2	3	4	5
Our product design enables repair, rework and recycling	0	1	2	3	4	5
Our product design facilitates disassembly	0	1	2	3	4	5
We adhere to environmentally related programmes, standards and regulations	0	1	2	3	4	5
We prolong the service life of products by providing maintenance and support to customers	0	1	2	3	4	5

Please indicate a level of your agreement or disagreement with each of the following statements, indicate your opinion to the appropriate column by circling your answer, (0 = strongly disagree, 1 = disagree, 2 = somewhat disagree, 3 = somewhat agree, 4 = agree, and 5 = strongly agree).

Our main dealer shares information to us about product–service offerings	0	1	2	3	4	5
Our main dealer and we have systems for monitoring and evaluating supply chain performance	0	1	2	3	4	5
Our main dealer evaluates our performance by its standards	0	1	2	3	4	5
We are capable of fulfilling certifications required by our main dealer for evaluating our performance	0	1	2	3	4	5
We have capability to follow the environmental regulation made by the Indonesian government	0	1	2	3	4	5
We offer a product take-back program	0	1	2	3	4	5
We advise our customers on how to use our products in an energy-efficient manner	0	1	2	3	4	5
We suggest our customers to regularly maintain their products	0	1	2	3	4	5
We offer refurbished motorcycles	0	1	2	3	4	5
We always improve service quality to fulfill customer needs	0	1	2	3	4	5
We are reliable to deliver our service on time	0	1	2	3	4	5

We are proficient to deliver an innovative bundling of product–service particularly in providing maintenance and repair services	**0**	**1**	**2**	**3**	**4**	**5**
We manage service capacity with uncertain demand	**0**	**1**	**2**	**3**	**4**	**5**
We always improve service management facilities	**0**	**1**	**2**	**3**	**4**	**5**
We have been providing a bundling of products and services to increase our profit	**0**	**1**	**2**	**3**	**4**	**5**
We have been delivering a bundling of products and services that make improvements to our market share	**0**	**1**	**2**	**3**	**4**	**5**
We have been improving the opportunities of the surrounding community in respect of employment	**0**	**1**	**2**	**3**	**4**	**5**
We have been improving the occupational health and safety of our employees	**0**	**1**	**2**	**3**	**4**	**5**
We have been improving our compliance with environmental standards	**0**	**1**	**2**	**3**	**4**	**5**
We have been decreasing the use of hazardous, toxic and harmful materials in manufacturing our products	**0**	**1**	**2**	**3**	**4**	**5**

Thanks for your participation!

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