

Indonesia in the Headlight: Fighting Sustainability Through the Implementation of the Product-Oriented Product–Service Systems

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ABSTRACT

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This research focuses on Indonesia's efforts to promote sustainability through the implementation of product-oriented Product-Service Systems (PSS). The study first explores the Indonesian government's support for sustainability and then examines the existing implementation of product-oriented PSS in the Indonesian motorcycle network. The paper investigates the drivers and barriers of product-oriented PSS implementation to improve sustainability through semi-structured interviews with thirteen senior managers from five Indonesian motorcycle companies, including manufacturers, intermediaries, and service partners. The study identifies key criteria for manufacturers to meet sustainability, such as waste management, reducing hazardous material usage, designing for disassembly, increasing the use of recyclable materials, and implementing take-back and recycling policies. For intermediaries and service partners, the key criteria include providing services, repairs, and maintenance, as well as reducing the use of hazardous materials. Finally, the study offers recommendations based on previous research on the role of government in overcoming barriers to product-oriented PSS implementation. This study contributes to the body of knowledge on improving sustainability through product-oriented PSS implementation by identifying drivers and barriers.

1. INTRODUCTION

The recognition of environmental awareness in the automotive industry has been a major concern [1]. It is widely acknowledged that the automotive industry is a significant economic force in the world and thus should be responsible for global air pollution. In Indonesia, the motorcycle industry dominates the automotive industry, as sales of motorcycles are five times higher than sales of cars according to the sales report in the first semester of 2019 [2]. Together with cars, the motorcycle industry contributes 5.44% to the nation's economic growth in the second quarter [3]. However, the air quality in Indonesian cities has worsened due to the large amount of emissions from motorcycles and cars.

The implementation of product-oriented Product-Service Systems (PSS) has the potential to reduce the environmental impact. Annarelli et al. [4] define PSS as a business model focused on the provision of integrated products and services that is formulated to improve sustainability and satisfy customers' needs. In other words, PSS solutions aim to replace or substitute the sale of products with solutions that have the potential to decrease the environmental burden [5].

The frequent renewal of motorcycles by customers has contributed to the increasing volume of waste, along with the hazardous chemical ingredients inside the motorcycle [6]. Contrary to the concept of sustainability, many people replace their products not because of functional problems but for aesthetic purposes [7]. Several motorcycle manufacturers have reshaped their thinking to be more sustainable. To achieve

sustainability, there are three categories based on the life cycle of the product, including sustainable product design and development, sustainable manufacturing processes, and sustainable end-of-life management [8]. Sustainable product design aims to reduce hazardous materials and waste, increase recovery through maintenance and repair, rework, and recycling [9]. Sustainable manufacturing processes include reducing energy consumption and CO₂ emissions in adherence to government standards. Finally, sustainable end-of-life management refers to product recovery after usage, such as reuse, remanufacturing, and recycling [8].

The motorcycle industry is facing significant environmental issues, predominantly due to the high level of waste generated at the end of the product life cycle [10]. Two solutions to this issue are to decrease the consumption rate by prolonging the product's lifetime and to use material recycling [11]. Both can be achieved by proposing the concept of product-oriented Product-Service Systems (PSS). This approach has shifted the paradigm of manufacturing and selling towards providing an integrated solution of product and service [9]. Examples related to the automotive industry include refurbishment product offerings, take-back product offerings, warranty contracts, maintenance contracts, spare parts and component offerings, and fuel efficiency information services [10].

There are three types of Product-Service Systems (PSS): product-oriented PSS, use-oriented PSS, and results-oriented PSS [12]. Product-oriented PSS offers a bundle of product and services, including a service contract as a guarantee of product functionality and durability. Use-oriented PSS provides access

to the product through leasing or sharing, while results-oriented PSS offers the result or capability of the product, such as providing laundered clothes instead of selling a washing machine. As the main business of the motorcycle industry is selling a product that includes a service contract, this study limits its discussion to the product-oriented PSS.

Furthermore, companies have become more aware of the need to include sustainability in the redesign of existing products to be more environmentally friendly [13]. This involves developing environmental efficiency by selecting low-impact materials and energy sources, reducing the use of non-hazardous materials, increasing the use of recyclable materials in products, and prolonging the product's lifetime through maintenance and repair services [14]. Manufacturers are responsible for this stage. Many motorcycle manufacturers have made efforts through partnerships with service providers to extend the lifespan of their products through maintenance and repair. To achieve this, manufacturers' capabilities, including knowledge assessment, partner development, co-evolution, reflexive control, re-conceptualization, and innovative service delivery, should be transferred to a network of service partners who are obligated to perform maintenance and repair services [15]. Therefore, collaboration with a network of service partners allows manufacturers to provide Product-Service Systems.

Based on the above arguments, this study focuses on Indonesia's government regulations to support the implementation of product-oriented PSS. First, the study reviews the literature on the Indonesian government's role in supporting sustainability and the development of the Indonesian motorcycle PSS network. Then, semi-structured interviews were conducted to understand the drivers and barriers to the implementation of product-oriented PSS in the Indonesian motorcycle industry. Finally, recommendations are made based on the literature review of successful PSS implementation experiences in other countries. In summary, this study offers a new perspective on improving sustainability by identifying the drivers and barriers to implementing product-oriented PSS.

This study has several justifications. First, there is still limited literature on PSS in the context of developing countries [9]. In a recent systematic literature review on PSS by Kurpiela and Teuteberg [16], strong contributions were found from developed countries. However, the differences in characteristics between developed and developing countries mean that the publication contributions and conclusions from developed countries may not be applicable to developing countries. By using Indonesia as a context, this study may contribute to the scarce literature on PSS studies in developing countries, and the conclusions reached may be applicable to other countries with similar characteristics. Second, the strategy for achieving sustainability may not be the same for developed and developing countries. For example, the capability to build the infrastructure to implement a closed-loop supply chain is considerably different [8]. Therefore, developing countries may need to find a different way that is reasonable in the light of current conditions to achieve sustainability performance. Third, a significant reason for choosing Indonesia as the subject of examination is the urgency of the sustainability issue. The air quality in most big Indonesian cities has worsened due to the large amount of motorcycle and car emissions.

2. LITERATURE REVIEW

2.1 Indonesian government support for sustainability

Recognizing the concerns over global warming, the Indonesian government voluntarily committed through Presidential Decree No.62/2013 to a minimum 26% reduction in greenhouse gas emissions by 2020 [17]. In response to the United Nations' new Sustainable Development Goals, which aim to protect the planet and end poverty around the world, Presidential Decree No.59/2017 was issued to achieve those goals within Indonesia [18].

To ensure sustainable development without worsening the impact on the environment, the Indonesian government has imposed a series of regulations. For example, Law No.32/2009 on Environmental Protection and Management enables the government to implement a variety of environmental instruments, including environmental financing, eco-labelling, and green public procurement. Other regulations include Ministry of Environment Regulation No.18/2008 about hazardous and toxic waste management and Presidential Decree No.02/2015 on sustainable consumption and production. Government Regulation No.27/2012 on environmental impact assessment for new businesses aims to measure environmental impact [19]. Likewise, Government Regulation No.46/2017 establishes incentives for enhancing environmental management.

In 2016, the Indonesian government adopted ISO 14040/44 as a national standard, which is a significant step in its commitment to the environment, even though these certifications are still voluntary. However, Life Cycle Assessment using quantitative measurements, such as the product's carbon footprint (ISO 14067) and the environmental product declaration (ISO 14025), has not been widely implemented in Indonesia [18]. In summary, it has been shown that the Indonesian government has already established policies and regulations to promote sustainable practices in the industry, but several are not mandatory [20].

Finally, a series of Indonesian government regulations support the growth of electric vehicles [21]. For example, Presidential Decree No.55/2019 was issued to accelerate the battery electric vehicle program for road transportation, Ministry of Energy Regulation No.13/2020 was issued to support the battery charging station infrastructure for electric vehicles, and the regulation by the Ministry of Domestic Affairs No.8/2020 provides reduced tax for electric vehicles. Similarly, the regulation by the Ministry of Communication No.45/2020 addresses the safety of electric motorcycle users.

2.2 The development of the Indonesian motorcycle network

Although a crucial sector of the manufacturing industry in Indonesia, the motorcycle industry is dominated by Japanese manufacturing companies such as Honda, Yamaha, Suzuki, and Kawasaki. Foreign direct investment aims to increase knowledge and technology transfer, and ultimately stimulate economic growth [22].

Currently, only five motorcycle manufacturers are registered according to the Indonesian motorcycle association, namely Honda, Yamaha, Kawasaki, Suzuki, and TVS. Honda is the market leader with a 68% market share, followed by Yamaha with a 27.8% market share, and the remaining 4.2% is divided among three other brands [23].

There is growing demand from the market that automotive manufacturers should provide service and repairs. Therefore, motorcycle manufacturers have developed collaborative arrangements with intermediaries and service partners to provide PSS. In the Indonesian motorcycle industry, the term "main dealer" is commonly used instead of intermediaries, so this term will be used in this study going forward. The motorcycle distribution and after-sales service network in Indonesia is organized through the main dealers, who distribute the motorcycles and handle after-sales service with the collaboration of a network of service partners. Given the size of Indonesia, each main dealer must develop a network of service partners within its region. The main dealers deliver technical knowledge and partner development, facilitate service implementation, and act as mediators between manufacturers and a network of service partners [24].

3. METHOD

This research uses the qualitative approach—semi structured interviews for evaluating the sustainability through the implementation of product-oriented PSS in the Indonesian motorcycle industry. This approach has been chosen due to several justifications: the capability to get in depth understanding of the drivers and barriers of the product-oriented PSS implementation and the opportunity to ask follow-up questions.

The semi-structured interview has been developed and consist of two sections. First section asked about the participants' demographic information, including their position, working duration at the company and working duration at the current position. Second section asked about PSS implementation, sustainability, drivers and barriers to implement the PSS. Interview questions then were pretested by two academics and three motorcycle industry experts.

Thirteen interviews with five Indonesian motorcycle manufacturers, main dealers and service partners were conducted (Table 1). In order to keep the anonymity of the brands then the initial of the brand in Table 1 is not the abbreviation of any brands. The invitation for interviews were sent to the General Manager, Supply Chain Head, Head of Technical Service Development and Head of Service, all of whom worked in their position for more than one year. The position of Supply Chain Head and Head of Technical Service Development are the highest position in the motorcycle company so their position are categorized as the Chief Executive Officer. Thirteen interviews can be justified because all motorcycle brands have been represented by the manufacturers, main dealers and service partners from five brands. Interviews were recorded and then transcribed, they lasted between 21 and 32 min.

This study adopts credibility, transferability, dependability, confirmability and reflexivity to ensure the validity and reliability of the research findings [25]. The recording was cross-checked with the notetaking to ensure the credibility. To ensure the transferability, the outcome of themes was

compared to the transcript. Further, to check the accuracy of the meaning to ensure the dependability, several participants were asked again to check the researcher' understanding was correct. Likewise, confirmability was conducted for the thematic process by matching to the theme. At last, after long thought and analysis, the researcher realizes the potential biases for the study (reflexivity).

Table 1. The participants involve in interview

Participant	Brand	Manufacturer/ Intermediary/ Service partner	Working since (year)
A	W	Manufacturer	2003
B	W	Main dealer	2006
C	X	Manufacturer	2017
D	X	Main dealer	1998
E	Y	Main dealer	2000
F	Z	Main dealer	2008
G	W	Manufacturer	2006
H	Y	Manufacturer	2015
I	W	Service partner	2014
J	X	Service partner	2012
K	Y	Service partner	2019
L	Z	Service partner	2018
M	A	Service partner	2019

The thematic analysis was carried out so that all statements from participants were categorized as their similarities. The coding was given to the items with similarities, then clustered into the same theme. Not all quotations were translated to English, only selected quotations were reported in this study are translated into English, and is done by the language expert to ensure the reliability and validity.

4. RESULTS AND DISCUSSION

After thematic analysis was done, there are two themes: drivers and barriers to the product-oriented PSS implementation. The first section presents the findings on the various components from first theme—drivers of product-oriented PSS and the second section presents the findings on two components from second theme—barriers.

The PSS concept has the potential to improve sustainable practices; however, the main motive driving companies to adopt PSS is their desire to stay competitive in the market [5]. The motivation to use a PSS is mostly triggered by economic drivers and customers' responses to PSS implementation [4]. The adoption of PSS is driven by companies wanting to add value to their products, improve their relationship with customers, increase company profits and improve sustainability performance [5]. Customer responses are usually exceptional as they receive more benefits from PSS offerings. In fact, the benefits mostly outweigh the challenges; hence, all interviewees had been involved in implementing a PSS in their organisation and overcome the resulting challenges.

The theme for drivers of product-oriented PSS includes economic motivation, market pressure, environmental regulation and lean manufacturing. The theme for barriers is presented later in section 4.2, includes limitation of service partners' capability and limitation of manufacturer capability to handle both greener alternative material and product end of life.

4.1 Drivers

4.1.1 Economic motivation

All manufacturer participants reported that the strongest motivation for PSS adoption and collaboration with their main dealers and service partners was economic motive: they want to increase profits. The motorcycle is a complex machine with both mechanical and electronic components, making it difficult for customers to carry out all maintenance tasks. Therefore, all participants concurred that the availability of official motorcycle service centers is considered as crucial by customers who were considering the purchase of a motorcycle. Service centers are essential for the customers to provide proper maintenance during the product's life cycle. Main dealer E explained on why his company has implemented a PSS:

"As a main dealer, we have sensed of strong belonging to the brand. We have to work hand in hand with the manufacturer to provide a bundle product and service. It strengthens our brand and of course, we make a lot of profit from servicing and selling spare parts" (Main dealer E).

The players with a large market share emphasized that their intentions to implement product-oriented PSS was mostly driven by economic considerations: they wanted to increase profits and market share. On the other hand, those with a smaller market share wanted to retain their portion of the market and survive. They too stressed that a good company image could be established by providing trustworthy product warranties and excellent after-sales service to customers. The evidence as spoke by the service partners I:

"We choose to become a service partner of brand W because the brand is motorcycle market leader. We believe with the big market share; we can get many customers to buy our service. Becoming of brand W partner is a good investment and business as we can get decent profit for our investment" (Service partner I).

4.1.2 Market pressure to collaborate with main dealers and service partners

The complex nature of PSS offerings mean the need for development of special capabilities, as building a relationship with customers requires knowledge of product and service offerings and the customers' expectations [26]. Automotive products are complex and usually require service and maintenance efforts to lengthen their lifetime [27, 28]. Further, the customer requirements and expectations in providing timely servicing or after-sales maintenance to automotive products has become an essential part of the value proposition in the automotive industry [29]. Replacement, regular maintenance and repair services are usually included in the initial warranty period [6], the service partner J comments as below:

"We are implementing the PSS to give satisfactory service to all customers who have already bought our motorcycle. In fact, our customers have chosen us because of our wide service network" (Service partner J).

One player, who has received the Service Quality Award from the Centre for Customer Satisfaction and Loyalty, has a larger number of service centres than the smaller players. Main dealer D made this comment about customer response:

"Our customers are happy with our services and service network. They have responded well to our WhatsApp blast systems that remind them when their motorcycles are due for maintenance" (Main dealer D).

Another comment from main dealer B emphasised that customers were loyal because his company provided excellent PSS offerings:

"Our customers responded well to our PSS offerings. They are loyal customers. This is a sign that our PSS offerings went well. We got an excellent customer response which can be measured through our Customer Satisfaction Level and Technical Satisfaction Index" (Main dealer B).

From the quotations, it is clear that customers' response to PSS was the main reason for the manufacturers continuing to improve the collaboration with the main dealers and service partners. In fact, the PSS offerings are considered a major factor in determining the customer's important decision to buy a motorcycle [15]. Likewise, [30] confirmed that a PSS could be used as an indicator of customer loyalty and satisfaction.

The Indonesian motorcycle manufacturers have long-term collaborations with many service partners throughout Indonesia to be able to provide motorcycle maintenance and repair to customers, answering the market pressure. Based on the interview with the manufacturers, service partners and main dealers in the Indonesian motorcycle industry, they have been practicing long-term collaborations since they started the production. For example, one of the biggest motorcycle brand have collaborated with 3646 of service partners throughout Indonesia [31].

Manufacturers as the source of knowledge support a network of service partners with knowledge, system and partner development assistance. One participant expresses the system they have and how they manage their collaboration with service partners to deliver the product-oriented PSS.

"We understand that we have to support our service partners because they have less capability and knowledge of product and service. We provide product and service knowledge through a series of training. We have two different kinds of training. One is product training and the other is about the service training. Our product training including regular maintenance, troubleshooting, management and environment safety. We also provide practical customer service training including basic principle of service, professional image of front liner and complaint handling" (Main dealer F).

The other main dealer participant adds that they also provide rigor assistance for their service partners, as quoted by main dealer B below:

"We do have system to assist the service partners to do their part. We regularly have a meeting every two weeks. Even, we can assist them by phone if our service partners need technical guidance" (Main dealer B).

The activity of maintenance and repair of the motorcycle during its life time, include providing an official guarantee from a motorcycle manufacturer, will prolong products' lifetime. This contributes to the sustainability performance of the motorcycle industry [10].

4.1.3 Environmental regulation

Environmental regulation by the Indonesian government has not as strict as in the developed countries. For example, the Indonesian government does not require the producer to take responsibility on the product end of life waste. However, general environmental regulation has been followed by all interviewee participants. For example, the service partners have been practicing sustainability by complying to the environmental regulation. One participant expresses their concern on environment as follows:

"In our service facility, we collected the used oil, tire, battery and plastic bottle. We deliver to third party for recycling purposes" (Service partner J).

The environmental redesign of existing product is conducted by reducing the hazardous materials. Based on the interviews, the manufacturer participants have been practicing sustainability practice as early as product design. All manufacturers have reduced the use of hazardous materials, exemplified as follows:

"We have banned the use of asbestos that we used to use for brake part. The use of asbestos is dangerous because when the asbestos are damaged then the substance are transmitted to the air and caused threatening diseases. Further, customers have to collect the battery and send to us, we then recycle the lithium waste inside the battery. We also develop our motorcycle machine using smart engine which is developed to use high performance injection technology leading to the efficient use of fuel with the high performance of machine, low emission, lengthen the product life cycle and environmental friendly" (Manufacturer A).

Further, participant C adds comment as follow:

"We design our products to be easy to disassembly for maintenance and repair purposes and later on for increasing the utilization of used component in the future. We also consider the environmental effect on material choices and follow standard environmental regulations determined by the Indonesian government. In addition, we provide PSS to prolong the motorcycle lifespan" (Manufacturer C).

Moreover, the cornerstone of the Indonesian government goal is toward carbon neutrality by shifting away the fossil-based transportation. This improves the air quality, particularly in the dense big cities in Indonesia.

"As part of our responsibility to the sustainability to decrease the pollution, we have developed several types of electric vehicles. We have prepared the battery charging station and hope to be prepared in 2025. In the meantime, our electric vehicles have been rented out to Gojek as we yet not prepared to sell to an individual customer. However, we wish to prepare in 2025" (Manufacturer G).

Based on the interview with all manufacturer participants, they have followed the guidelines determine by the Indonesian government, for example to adhere to the ISO 14000 about environment restrictions, also have eliminated the using of asbestos as it is harmful to environment and replaced with materials with lower environmental impact.

4.1.4 Lean manufacturing

As discussed in the literature review that environmental improvement throughout the SC is the initial step towards the sustainability. Interviews with the Head of Supply Chain of the Indonesian motorcycle manufacturer indicated that motorcycle manufacturers have been practising Just-In-Time or lean production management. It means that they have already minimised setup time, using smaller lot size and Kanban implementation to control the inventory. As a result, the production capable to minimise all waste including overproduction, defects, waiting time, raw materials, scrap, work in process and finished goods. Manufacturer H remarked as follows:

"We have practiced lean manufacturing in our production site. We have minimized all waste including overproduction, defects, waiting time, raw materials, scrap, work in process and finished goods. We have implemented pull production system that allow us to know the real demand from market so

that we able to manage reasonable lot size. We also have used the Kanban card to control our inventory. Our challenges are to support our main dealers and service partners to implement the waste management in their process" (Manufacturer H).

4.2 Barriers

4.2.1 Limitation of service partners' capability

It has always been difficult to manage a SC network in Indonesia because the country is the largest archipelago in the world with a total number of 17,508 islands, about a third of which are inhabited. One challenge is the difficulty of accessing the internet in many remote areas in Indonesia. As stated by service partner K:

"Due to the difficulty in accessing an internet connection, specifically in the remote areas, we have been assisted by our main dealer manually by phone. The assistance required for helping us with technical problems" (Service partner K).

The motorcycle industry is a knowledge-intensive industry that requires its technicians to be highly skilled. The challenges of dealing with technicians in remote areas are considerable, as expressed by main dealer D:

"Our challenges to ensure the same standard of service among regions are huge. We have standardized our services by giving a series of training courses and certificates to guarantee the technicians' service capabilities. However, in reality we are dealing with a lack of skills of our technicians, especially in the remote areas outside Java" (Main dealer D).

Another challenge faced by the players with smaller market share is the difficulty of retaining their current service partners because of the size of their market. On the other hand, the players with the bigger market share do not have any difficulties attracting and collaborating with new service partners. However, all main dealer participants reported a reluctance by service partners to follow the business rules established by the main dealers. Frequently, new motorcycle model requires new equipment and tools to be installed in the facilities. Some service partners do not want to invest in new equipment and tools because of budget constraints. This then affects their business as they are now unable to service the new motorcycle model and consequently lose some profit, as explained by service partner M:

"We have faced challenges if the main dealer force us to upgrade to the new service facilities or add new investment for new toolsets for new motorcycle types. We know that these enhancements need new investment, but the we cannot afford high investment in new tools" (Service partner M).

Overall, the PSS challenges can be resolved through better communication. The reluctance of service partners to invest might be solved by offering arrangements that can lead to profit, while the internet access challenges can be overcome by improving the infrastructure in the remote areas, although this is not something that the main dealers and service partners can control.

All main dealer and service partner participants revealed that their customers responded well to the PSS offering. Customer preference in choosing a motorcycle brand is partly based on the number of accessible service centers and the capability of those centers to provide maintenance and repair services. The players with small market share find it difficult to expand their service partner network because they have a smaller customer base and they cannot compete in terms of every aspect of business operations. As a result, the small players' customers were less satisfied with the limited service

offered by a smaller partner network. Service partner L made this comment on customer response:

"Our market share is so small. Our existing customers are leaving us and they buy market leader brand. We also have difficulty attracting new customers as the market leader products are more attractive" (Service partner L).

Consequently, the non market leader players have only a few service partners and that's not enough to fulfil the availability of official service partners needed in the market. They know that their customers are not happy with the situation.

Table 2. Summary of the drivers and barriers to meet product-oriented PSS implementation and the solution to overcome the barriers

Stake holders	Key criteria of PSS implementation	Drivers to meet sustainability	Barriers to meet sustainability	Government policy to overcome the barriers [32]
Manufacturers	Waste management	<ul style="list-style-type: none"> Lean manufacturing practice. <ul style="list-style-type: none"> Pull production implementation using Kanban card. 	-	General policies: <ul style="list-style-type: none"> Guideline good practices to businesses for keeping safety environment. Applying environmental cost: pollution charges, taxes and fiscal incentive for pollution reduction. <ul style="list-style-type: none"> Applying extended producer responsibility programmes. These programmes encourage the manufacturers for taking responsibilities on their End Of Life (EOL). The solutions to these problems related to the product take-back, recovery, refurbishment and recycling. Applying informative policies such as eco-labelling, consumer advices and campaign to inform customers about the efficient usage of the products. Adding and improving public transport and infrastructure to minimize the use of private vehicle
	Decreasing the hazardous material uses	<ul style="list-style-type: none"> Responsibility to follow the Indonesian government regulations to the environmental safety. <ul style="list-style-type: none"> Responsibility to the environmental sustainability. 	<ul style="list-style-type: none"> The alternative greener materials are more expensive. No incentive received from the government. 	
	Design for disassembly and increase the recyclable materials	<ul style="list-style-type: none"> Create modular design that increase the utilization of used components. <ul style="list-style-type: none"> Responsibility to the environmental sustainability. Pressure from government and market. 	<ul style="list-style-type: none"> Economic interest conflict as a manufacturer who produce products and make profit from them. No incentive received from the government. 	
	Take back and recycling policy	<ul style="list-style-type: none"> To control the products' second market price. Extending products' life span. 	<ul style="list-style-type: none"> Recycling procedures are relatively costly and infeasible for business. Lack of technology and external infrastructure for product collection and recycling. <ul style="list-style-type: none"> Difficult to control. Escalating the cost of labour for handling. Second-hand motorcycles are easy to sell. No incentive received. 	
Main dealers and service partners	Providing service, repair and maintenance	<ul style="list-style-type: none"> Market pressure from customers who require integrated bundling of product and service. Improve relationship with customers. Capability to provide service, repair and maintenance. <ul style="list-style-type: none"> Responsibility to the environmental sustainability though maintenance that could prolong product' lifetime. Responsibility to extend motorcycle life span by maintenance. Economic motive to get more profit and market share. 	<ul style="list-style-type: none"> Service partners have less resources and capability to implement PSS such as difficulty accessing internet connection in remote areas. <ul style="list-style-type: none"> Ensuring the same standard of service among service partners is a challenge. Service partner refuse to put a new investment on new tools and service facilities. For a small market share companies, it is hard to attract new collaboration with new service partners. 	The product-oriented PSS-targeted policy including: <ul style="list-style-type: none"> Stimulating and supporting companies to develop the PSS-oriented solutions Supporting companies to overcome the barriers of developing the PSS <ul style="list-style-type: none"> Supporting the professionals to capable of designing, implementing and managing the PSS Giving the incentive to the development of project related to PSS eg. incentive for vehicle pooling that has possibility to share a ride, internalised the external cost.
	Decreasing the hazardous material uses	<ul style="list-style-type: none"> Responsibility to the sustainability of environmental safety. Pressure from government and market. 	-	

4.2.2 Limitation of manufacturer capability to handle both greener alternative material and product EOL

At the end of the product useful lives, the treatment of the recyclable and hazardous components often used in automotive products creates a massive challenge for companies [33]. PSS motivates companies to engage with product take-back as part of their extended responsibility as producers [10, 34]. However, it is not the case in the Indonesian motorcycle industry. From the interviews with the manufacturer participants, they still do not have a plan in the short term to implement the extended producer responsibility for motorcycle industry, as illustrated by manufacturer A below:

“Until now, we have not offered product take back for refurbishment. Our service partners might have offered a product take-back but for the purpose of reselling the old and buying the new product, so it is more like trade-in. This is a way for us to control the second market price for our product. The reasons why we are not offering product take-back because we do not have capabilities or infrastructure ready for recycling. The infrastructure cost is too high and we cannot include that cost at the motorcycle price as the product becomes too expensive” (Manufacturer A).

Further, all manufacturer participants have acknowledged that forcing by a series of the Indonesian government regulations to the environment, they have to take care of the environment by decreasing the hazardous material uses. However, manufacturer C then add their challenges to produce greener technology to compete with non-greener technology, as below.

“We realize that it is more friendly to our environment if we use greener materials to our product; however, we are limited by the society capability to buy our product if the product price is higher than common product. We aware that we can use recycle part from the product end of life and make a refurbished product, but then our resources, infrastructure and technology do not support this. Unless, there is support from the government, for example the reduced tax for a greener product, then we might compete with a non-greener product” (Manufacturer C).

All manufacturer participants said that there is a possibility that the unused motorcycles are exported to the other countries and then in the meantime the manufacturers do not have problems with the motorcycle end of life. Further, the informal sector takes the benefit of the motorcycle EOL to use the components which have economic values to be used for different purposes. These practices are common in the less developed countries, actually this practice helps the micro and small enterprises. The summary of the drivers and barriers to meet product-oriented PSS implementation and the solutions to overcome the barriers is in Table 2.

5. CONCLUSIONS

The main purpose of this paper is to investigate the implementation of product-oriented PSS to improve sustainability by examining the drivers and barriers. Thematic analysis revealed two themes: drivers and barriers of product-oriented PSS implementation. The drivers are economic motivation, market pressure to collaborate with main dealers and service partners, government regulations, and lean manufacturing. The barriers are the limitation of service partners' capabilities and manufacturers' capability to handle

both greener alternative materials and product EOL. This study found that key criteria for manufacturers to meet sustainability are waste management, decreasing hazardous material usage, designing for disassembly, increasing recyclable materials, take-back and recycling policies, while for intermediaries and service partners are providing service, repair, maintenance, and decreasing hazardous material usage. The findings from this study also revealed three stakeholders within the SC network that have long-term collaboration to achieve the same goals. They have different roles in the SC network, but working together in harmony can achieve sustainability. The main dealers hold crucial roles as intermediaries to bridge manufacturers and service partners' needs and transfer knowledge and skills to service partners. Manufacturers are the producers who own intellectual property of product and service knowledge. Service partners, who have direct contact with customers, have important roles in delivering PSS to customers. Finally, recommendations were made based on literature review done in developed countries, including general policies and policies to expedite PSS implementation.

This study contributes to the scarce PSS literature, from both theoretical and practical perspectives in developing countries, as most papers were studied in developed countries. From the theoretical perspective, this study provides an improved understanding of examining the current implementation of product-oriented PSS by knowing the drivers and barriers. From a practical perspective, this study provides the Indonesian government and the motorcycle industry with relevant suggestions on how to enhance the implementation of product-oriented PSS.

This paper has some limitations; however, they can be seen as future research directions. First, this study is dedicated to the motorcycle industry in a limited geographical area. Hence, further research should apply to various industries in broader areas to assure the generalization of the results. Second, this research focuses on product-oriented PSS, where the primary focus is still on selling products, accompanied by the service as added value. Results-oriented PSS, on the other hand, has the potential to provide more benefits when it comes to the impact on the environment. Therefore, further research might investigate the drivers and barriers to implement results-oriented PSS.

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APPENDIX

Part 1 - Demographic information of participants

Q1) What is your position in the organization?

Q2) How long have you worked for the company and in this position?

Part 2 – The purpose of this section is to investigate drivers and barriers of the PSS implementation in the Indonesian motorcycle industry

1. The role of the participants
 - How is your role in this firm to implement product-oriented PSS and to increase the level of sustainability?
2. PSS implementation, sustainability, drivers and barriers to implement PSS
 - When did your company adopt PSS?
 - Why did your company decide to adopt PSS to improve sustainability (tell me your motivation/drivers, expectations and goals)?
 - Were there any challenges/barriers when your company adopted PSS to improve sustainability? For example, start and manage the partnership with the service partners. Please name any challenges you have.
 - How did your customers respond to the adopted PSS?
 - How have you managed the collaboration and partnership with main dealers and service partners? Give an example.
 - Give me the example of your company concern about sustainability with the PSS implemented in your company. For example, do you use recycling and reuse materials? Do you offer a take back motorcycle and sell refurbished motorcycle? Do you decrease the use of hazardous materials? Do you follow the environmental regulations by the Indonesian government?
 - Do you have solutions to the challenges/barriers you face?