KnE Social Sciences

The 1st International Conference on Creative Design, Business and Society (1st ICCDBS) 2023

KNE Publishing

Research Article

Simplification of Product Design to Enhance the Sustainability Product Service System (SPSS)

Ahmad Nur Firmansyah* and Bambang Iskandariawan

Interdisciplinary School of Management Technology, Institut Teknologi Sepuluh Nopember, Indonesia

ORCID

Ahmad Nur Firmansyah: https://orcid.org/0009-0007-3100-2956

Abstract.

In today's society, many donation programs still operate using a linear economy (LE) business model. This approach restricts donated products to their intended recipients without returning them to the manufacturer or distributor for repair, maintenance, or product enhancement. Unfortunately, this often leads to more waste when products can no longer be reused and are immediately disposed of. Our research aims to simplify innovative products and strengthen the connection between products and sustainable services to establish a circular economy (CE) using the product service system (PSS) business model. We utilized design thinking, a four-stage method, to accomplish our goal. We began by analyzing products available for sale and considering the perceptions of users, manufacturers, and distributors. In the defining stage, we formulated product design specifications (PDS), followed by prototyping and testing. Our research results focus on the requirements of users and manufacturers and the qualitative amalgamation of product services in the form of PDS. These findings have the potential to impact the development of a more efficient sustainable product service system (SPSS).

Keywords: linear economy, circular economy, product service system, product design specifications

Corresponding Author: Ahmad Nur Firmansyah; email: ahmadnfirmansyah@gmail.com

Published: 19 November 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the 1st ICCDBS Conference Committee.

1. Introduction

There are many donation programs available that provide support to local communities by offering goods or services, which can help improve their economic welfare and living standards. However, it is important to note that many of these programs still operate under a linear economic (LE) model that can have negative impacts on both the environment and society. Typically, the manufacturers of these programs provide donated items directly to users without any form of reciprocation, such as maintenance, continuous improvement, or product refurbishment. This results in a take-make-waste approach that is not sustainable. To truly make a positive impact, donation programs

must shift towards a circular economy model that prioritizes sustainable design principles and environmentally conscious practices. By doing so, they can promote the principles of a circular economy at all levels, from micro to macro, and ensure that economic, environmental, and social considerations are all taken into account.

In an LE, companies tend not to consider the environmental impacts of their business decisions. This approach has the potential to result in increased waste and environmental pollution [1]. On the other hand, economic and social performance has a positive and significant influence on financial performance, making the circular economy (CE) approach a potential solution [2]. CE represents a transformation from a linear economic model, focusing on the more efficient use of natural resources and better waste management [3].

Creating a sustainable product-service system (SPSS) can be a strategy for achieving a CE within marketing. Sustainable SPSS offers a potential solution for attaining CE goals [4]. The combination of products and services in PSS enables potential improvements in the product's performance throughout its lifecycle, benefiting customers, companies, and society [5]. To effectively implement the Product-Service System (PSS) business model, it is crucial to provide products that are environmentally conscious and recyclable. This enables the expansion of CE principles at all levels, from microeconomics to macroeconomics. Essentially, PSS relies on products that align with sustainable design principles and environmental considerations while also factoring in economic aspects. This is because the practice of recycling products through users returning used items for repair or maintenance purposes promotes a shift towards a Circular Economy in the product economy.

Through experimentation with marketing donated products, it has been discovered that simplifying the products can increase the value of SPSS. This can be achieved by streamlining the production process, simplifying materials and design, and making it easier to convey product knowledge to all relevant parties, including manufacturers, distributors, and users. By sharing product knowledge, stakeholders can be motivated to reuse the product, reducing waste resulting from direct disposal and promoting sustainable practices in marketing [6]. This concept has important implications for the development of SPSS in marketing.

2. Literature Review

2.1. Product Service System: Eight Categories

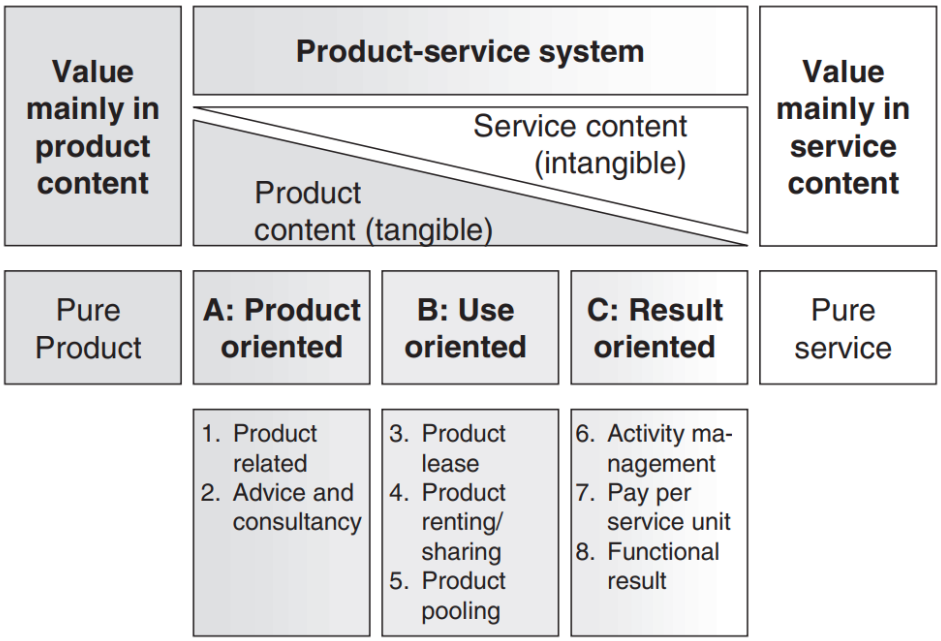

Figure 1: Categories and sub-categories in the PSS business model. Source: Tukker [7].

According to various studies, there have been several PSS category systems discussed. However, most of these studies indicate that PSS consists of three main categories (see Figure 1):

1. The first category is product-oriented services, where the focus remains on selling products, but it includes additional services like product repair and maintenance.

2. The second category is use-oriented services, where conventional products still play a significant role, but the emphasis is not on product sales. The products are retained by the provider and offered in different forms, which are sometimes shared among multiple users, such as rentals.

3. The third category is result-oriented services, where clients and providers enter into an agreement regarding outcomes without the involvement of specific predefined products.

Each of these categories has diverse economic and environmental characteristics, depending on the marketed products [7]. In the context of donations involving tangible product contributions, the categorization of the PSS can vary between product-oriented and use-oriented services. This determination largely depends on the distribution approach of the products and the complementary services provided by the involved stakeholders. If the donated products are intended for direct sale to users with post-sales services like product repair and maintenance offered by the organizers, then the product can adopt a PSS business model within the product-oriented services category.

2.2. Product Knowledge Influences

Xin & Ojanen underlined the importance of bringing together multiple stakeholders with distinct responsibilities and knowledge requirements in the realm of PSS for extensive networks that create value [6]. This necessitates comprehensive knowledge exchange among key players such as R&D professionals (designers), manufacturers, end-users, and recyclers. The integration of diverse knowledge related to economic, social, and environmental considerations across the entire product life cycle significantly amplifies the significance and complexity of knowledge management within companies operating in the PSS context, as highlighted in this research.

2.3. Hypotheses

From the comprehensive data collection that has been conducted, it becomes apparent that there is an unequal distribution of product knowledge, which can be attributed to various contributing factors. One of the contributing factors is the complexity of product design, which poses challenges in communicating product knowledge naturally or through extensive training.

1. Hypothesis H1: The complexity of product specification has an impact on the delivery of product knowledge.

2. Hypothesis H2: The complexity of product specification has an impact on the product service system.

3. Hypothesis H3: Product knowledge has a significant impact on product service system.

3. Methodology Research

As part of the data collection process, a pre-test was conducted to evaluate the level of knowledge among stakeholders regarding the products being marketed and sold. The evaluation conducted encompasses all stakeholders involved in the marketing of donation products, including the research and development (R&D) and manufacturing departments, as well as the marketing department. In the current context, the objective of the pre-test is to evaluate the level of product knowledge among all relevant stakeholders. The quantity of participants in the pre-test can be observed in Table 1 and distribution of product knowledge of Below Elbow Prosthetic Hand in Table 2.

TABLE 1: Participants Information of Below Elbow Prosthetic Hand Production Line.

Industry	Participant	Job Title
3D Printing	P1	R&D engineer
	P2	R&D engineer
	P3	QC manager
	P4	Production
	P5	CEO
	P6	R&D engineer
	P7	R&D manager
Electronic Components	P8	Production
	P9	Product planning
	P10	Procurement
Logistic	P11	Procurement
	P12	Sales
	P13	Customer service

The product design specification, which was previously developed by the Research and Development (R&D) department, will be revisited and enhancement process using the Six Sigma method. This will be achieved through the utilization of multi-voting by all relevant stakeholders. Six Sigma will primarily focus on the simplification of products in order to enhance the understanding of the products.

Six Sigma is a philosophy and methodology that employs statistical analysis to identify the root causes of quality issues and implement controls. It can be applied to various business processes, including manufacturing, product design, and supply chain management. This methodology aims to control parameters and minimize defects, with the objective of achieving zero errors [8]. Six Sigma requires a broad knowledge of mathematics, management, and the specific sector being addressed. It follows a structured approach known as DMAIC (define, measure, analyze, improve, and control) [9].

TABLE 2: Distribution of product knowledge of Below Elbow Prosthetic Hand.

Knowledges	Stakeholder						
	RnD	3D Print Production	QC manager	Electronic Production	Logistic Procurement	Sales	Customer Service
Number of parts	++	++	–	-	-	-	-
Mechanism	++	+	–	-	-	–	+
Assembly	++	–	-	–	-	-	-
Servo motor	+	-	–	++	-	-	-
Electonic trigger	+	-	–	++	-	-	-
Power source	+	-	–	++	-	-	-
Basic MRO	+	–	–	+	-	–	–

Key
++: Best understanding
+: Better understanding
–: Average understanding
-: Under-average understanding

TABLE 3: Old Product Design Specification of Below Elbow Prosthetic Hand.

Design	Features
Frame	Conventional Frame Modular All part joins with bolts Wide space for cables Complex
Electronic Components	2x 18650 batteries in serial connection Push button for trigger MG996R servo motor
Additional equipment	Manual book 2x 18650 battery spares Silicone sock

The old product design specification (PDS) (see Table 3)will be collectively evaluated with all stakeholders by gathering votes and additional suggestions into the PDS. All possible new features will be added to a single table according to their design type. Once all possibilities and suggestions have been fully gathered, a voting process will proceed for these features. The purpose of the voting is to determine the optimal features, which will then be tested and evaluated. voting results are shown in Table 4.

The vote indicates the removal of six features from the old PDS, along with the addition of three new features. The details of this new PDS will serve as a reference for the prototype, which will then be used to simulate the delivery of product knowledge to all relevant stakeholders.

TABLE 4: New Product Design Specification of Below Elbow Prosthetic Hand.

Design	Features	Vote
Frame	~~Conventional Frame~~	OOO
	Frameless	OOOOOOOOOO
	~~Modular~~	OO
	~~All part joins with bolts~~	OOO
	~~Wide space for cables~~	OOOO
	~~Complex~~	OOOO
	Compact	OOOOOOOOO
Electronic Components	2x 18650 batteries in serial connection	OOOOOOOOOOOO
	Charging port	OOOOOOOOO
	Push button for trigger	OOOOOOOO
	MG996R servo motor	OOOOOOOOOOO
Additional equipment	Manual book	OOOOOOOOOO
	~~2x 18650 battery spares~~	OOOOO
	Silicone sock	OOOOOOOOO

After completing the PDS revision and finalizing any potential additional features through the voting process, the next step is to conduct simulations for all stakeholders regarding the effective dissemination of product knowledge. The delivery of product knowledge will utilize a manual book as a medium. The manual book will contain instructions on product usage, explanations of product parts, problem-solving techniques, and maintenance procedures. The results of the simulation can be viewed in Table 5.

TABLE 5: Distribution of product knowledge with new PDS.

Knowledges	Stakeholders						
	RnD	3D Print Production	QC manager	Electronic Production	Logistic Procurement	Sales	Customer Service
Number of parts	++	++	+	–	+	+	+
Mechanism	++	+	–	–	-	–	+
Assembly	++	++	–	–	-	+	–
Servo motor	+	–	–	++	–	–	–
Electonic trigger	+	–	–	++	-	-	–
Power source	+	+	–	++	–	–	–
Basic MRO	++	+	+	++	–	+	+

Key
++: Best understanding
+: Better understanding
–: Average understanding
-: Under-average understanding

The results of the new PDS simulation indicate a significant positive change, although the main emphasis on improving product knowledge still lies within the logistics department. The positive changes are particularly noticeable in the 3D printing and electronics departments. Basic knowledge regarding MRO (Maintenance, Repair, and Operations) has significantly improved among all stakeholders, except for the frame design and electronic sections, where the improvement impact is not as noticeable.

TABLE 6: Sales activity before PDS revision.

Activity	Months					
	1	2	3	4	5	6
Repair Done	7	10	6	9	10	11
Maintenance & Spare part sells	10	11	14	15	16	15

TABLE 7: Sales activity after PDS revision.

Activity	Months					
	7	8	9	10	11	12
Repair Done	12	13	9	10	11	13
Maintenance & Spare part sells	17	19	20	17	16	18

The data collected for this study was based on sales activity during the first and second quarters of 2023 (see Tables 6 and 7). This includes the number of successful repairs of donated products handed over to distributors, sales data of spare parts to users, and maintenance activities of products that have been used for a minimum of three months.

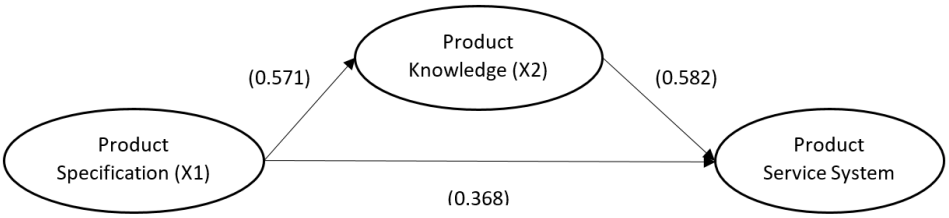

Figure 2: Framework of Thinking.

This framework of thinking focuses on the correlation between Product Design Specification (PDS) and Product Knowledge (PK), PDS and Product Service System (PSS), and finally PK and PSS (see Figure 2):

During the data analysis of PDS to PK, data collected from pre-tests and post-tests given to each participant. This analysis aims to understand how the design specifications

of a product influence the knowledge about the product. After analyzing the data, we found a significant value of 0.571 or 57.14% with a confidence level of 0.05. The obtained probability value of 0.002, which is less than 0.05, suggests that the Product Design Specification has a significant impact on the delivery Product Knowledges.

In the data analysis of PDS to PSS, collected data based on the number of products that were successfully repaired and returned to the user. This analysis aims to understand how the design specifications of a product influence the product's service system. Based on the data processing, we have identified a significant value of 0.368 or 36.82% with a confidence level of 0.05. Moreover, the probability value obtained was 0.036 which is less than 0.05, indicating that the Product Design Specification has a significant impact on the performance of the PSS business model.

Finally, in the data analysis of PK to PSS, collected data based on the number of products returned to each distributor for service, maintenance, or spare part purchase. This analysis aims to understand how product knowledge influences the product's service system. After analyzing the data, we discovered a noteworthy value of 0.582 or 58.28% with a confidence level of 0.05. The probability value we obtained was 0.004, which is below 0.05. This suggests that the Product Knowledge has a significant impact on the performance of the PSS business model.

4. Results and Discussion

To facilitate the delivery of product knowledge to relevant parties involved in the production of tangible donation products, the research will focus on simplifying design products. The research method will involve conducting post-test with all stakeholders in the production area, including manufacturers and distributors. The test will aim to ascertain the sources of knowledge acquired by all stakeholders regarding the produced products. After the simplification of the products is successfully executed, post-test will be conducted to validate the effectiveness of delivering product knowledge to all parties.

After conducting research, it has been found that there is a strong correlation between the Product Design Specification (PDS) and Product Knowledge, as well as the Product Service System (PSS). By optimizing the design of the PDS, benefits arise in driving the PSS. For example, simplifying the PDS allows for easier problem-solving by identifying issues from the simplified design. Additionally, limiting spare parts makes the list of

devices installed on the product more concise. This simplified PDS is crucial in conveying product knowledge to the user through the distributor. By doing so, the user can gain basic knowledge about the product regarding MRO (Maintenance, Repair, and Operations), allowing them to repair it themselves or send it back to the distributor for maintenance.

5. Conclusion

The conclusion of this research indicates that simplifying product design is essential for achieving SPSS (Sustainable Product Sales and Services) through product knowledge. Product knowledge can play a crucial role in the sustainability of tangible product marketing through its after-sales services, laying the foundation for future marketing efforts to concentrate on selling intangible products. Managing intangible assets is vital for the sustainability of a product-based business. It not only contributes to increasing business revenue but also helps in building customer loyalty, ensuring continued transactions with the business. Consequently, a natural bond of loyalty between customers and the business owner will develop.

However, there are still gaps in the research that can be improved. One area that needs further exploration is the lack of explanations for other factors that can enhance the use of SPSS, apart from relying solely on product knowledge as a reference for PDS. Therefore, it is hoped that future researchers can develop a product donation marketing system that does not adhere to a linear economic model. A linear economic model has the potential to generate waste that cannot be processed and becomes garbage.

Acknowledgements

This research was assisted by the entire committee of the Seribu Tangan Palsu Program, the organizer of the ABMAS Prioritas 2022 prosthetic hand product donation program at Institut Teknologi Sepuluh Nopember.

References

[1] Nikam J. Transformational change through a circular economy. Stockholm Environment Institute; 2019.

[2] Hutasoit D, Sembiring YCB. The Effect of Disclosure of Economic, Environmental and Social Performance on Financial Performance in Companies Listed on the Indonesian Stock Exchange 2016-2018. Jurnal Riset Akuntansi & Keuangan. 202;229-250.

[3] Moata MR, Tome VD, Kuang S, Gharu B. Improving Dry Land Cropting Patterns with a Circular Economy Approach Towards Agro-Ecotourism. Jurnal Pengabdian Masyarakat J-DINAMIKA. 2019;4(2).

[4] Vezzoli C, Kohtala C, Srinivasan A, Xin L, Fusakul M, Sateesh D, et al. Product-service system design for sustainability. 1st edition. Routledge; 2017.

[5] Andreasen MM, McAloone TC. Defining product service systems. In Meerkamm, H. (Ed.); Proceedings of 13. Symposium on "Design for X", Neukirchen; 10.-11. Oktober 2002. University of Erlangen-Nürnberg, S. 51 (Vol. 59).

[6] Xin Y, Ojanen V. Knowledge reuse in product-service systems. Sustainability (Basel). 2022;14(21):14504.

[7] Tukker A. Eight types of product–service system: Eight ways to sustainability? Experiences from SusProNet. Bus Strategy Environ. 2004;13(4):246–60.

[8] Markarian J. What is six sigma? Reinf Plast. 2004;48(7):46–9.

[9] Fersini D. Six sigma. In [eds]. Quality management: Tools, methods, and standards. Emerald Publishing Limited; 2019. pp. 153-166. DOI: 10.1108/978-1-78769-801-720191010