



## Product–service system mapping for educational service development in public primary schools

Wendy Febrianty Mardhiyah<sup>1</sup>, Primelshaddai Tongguran Manurung<sup>2</sup>, Nanang Alamsyah<sup>3</sup>,  
Mohammad Rachman Waluyo<sup>4</sup>

<sup>1,2,3,4</sup> Department of Industrial Engineering, Faculty of Engineering, Universitas Pembangunan  
Nasional Veteran Jakarta, Indonesia

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### ABSTRACT

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This study was conducted to identify the potential implementation of the Product–Service System (PSS) in primary education and to develop a conceptual model suitable for public elementary schools in urban contexts. The research was motivated by the limited application of PSS within the education sector, despite its extensive utilization in manufacturing and service industries to enhance efficiency, innovation, and customer value. A descriptive qualitative approach was employed to obtain comprehensive insights into actual service conditions, management practices, and resource utilization in SDN Kebon Kacang 05 Pagi. Data were collected using structured questionnaires aimed at analyzing institutional characteristics, resource capabilities, and quadrant eligibility within the PSS framework. The findings revealed that the existing condition of the institution was positioned in Quadrant 11 Pure Service, while the desired development direction pointed toward Quadrants 3, 6, and 20. Based on the analysis, five recommended quadrants were proposed: Quadrant 3 (Advice and Consulting), Quadrant 4 (Product-Related Software), Quadrant 5 (Product Lease), Quadrant 6 (Product Renting/Sharing), and Quadrant 7 (Product Pooling). These quadrants represented strategic opportunities to improve educational service quality through knowledge-based consulting, digital integration, resource efficiency, and collaborative resource sharing. The research concluded that PSS has strong potential to enhance innovation, service quality, and sustainability in primary schools.

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#### Corresponding Author:

Wendy Febrianty Mardhiyah  
Department of Industrial Engineering, Faculty of Engineering,  
Universitas Pembangunan Nasional Veteran Jakarta, Indonesia.  
Limo Raya No.8, Depok, West Java, 16514, Indonesia.  
Email: : [wmardhiyah@upnvj.ac.id](mailto:wmardhiyah@upnvj.ac.id)

## 1. INTRODUCTION

The quality of a product determines the sustainability of its production process. High-quality products attract consumers to purchase and use them continuously (Raesi et al., 2024). Conversely, poor product quality reduces customer satisfaction (Abigail et al., 2024).

and encourages consumers to switch to superior alternatives. Similarly, in the field of educational services, an institution's ability to develop innovative and high-quality educational offerings strengthens its institutional image, enhances stakeholder trust, and increases user loyalty (Anggraeni et al., 2025)

In this context, primary education institutions function not only as providers of learning services but also as suppliers of educational products of value. To create sustainable educational value, it is crucial to integrate the product dimension of learning with service-oriented approaches, enabling collaborative value creation and supporting broader social and innovation outcomes (Ding et al., 2023). One relevant approach is the Product-Service System (PSS), which represents an integrated system that combines material (product) and non-material (service) components, as well as defines the interrelationships and dependencies between them. A well-developed and market-adapted PSS can deliver functional benefits, specific effects, and enriched user experiences to achieve predetermined objectives (Gaiardelli et al., 2021; Marques et al., 2013; Mont, 2002)

The PSS concept was initially applied in industrial sectors as a *product-oriented* PSS approach to enhance efficiency, promote environmental sustainability, and generate customer value (Kolling et al., 2022). However, its application in the education sector, particularly at the primary school level remains limited. In fact, primary education plays a strategic role in shaping students' character, foundational skills (Syifa Salsabila Mahmuddah & Junaidi, 2025), and critical thinking abilities (Jegstad et al., 2025). By adopting PSS principles, schools have the potential not only to provide learning services but also to build a sustainable, efficient, and outcome-oriented value system.

This study focuses on SDN Kebon Kacang 05 Pagi, a public elementary school located in Central Jakarta. The school was selected because it represents the general characteristics of public educational institutions in urban areas, which often face challenges related to innovation and service management. These challenges include limited flexibility in resource utilization, dependency on fixed budget allocations, underutilization of educational facilities outside core teaching hours, and the absence of structured service innovation beyond conventional instructional activities. Educational resources such as learning equipment, digital tools, and specialized human capital are primarily used for internal purposes and have not been systematically managed to generate extended service value or collaborative benefits. As a result, service delivery remains fragmented, and opportunities for efficiency, innovation, and sustainability are not fully realized. In this context, the Product-Service System (PSS) approach becomes relevant as it offers a structured framework to integrate educational products (curriculum, facilities, learning tools, and outcomes) with complementary services (consultation, digital support, shared resource utilization, and collaborative programs). PSS enables schools to move beyond a purely service-based orientation toward a value co-creation system that optimizes existing assets while enhancing service quality and institutional sustainability.

This research contributes concretely to public elementary school management practices by providing an operational PSS quadrant mapping tailored to the characteristics of primary education institutions. The study offers practical guidance for school administrators in identifying feasible service development pathways, optimizing resource utilization through leasing and sharing mechanisms, and fostering inter-school collaboration. By translating the abstract PSS concept into actionable development options, this research supports evidence-based decision-making and provides a replicable reference for other public elementary schools facing similar managerial and service innovation challenges. The significance of this research lies in addressing the gap between the industrial applications of PSS and its limited adoption in education. While most PSS studies have concentrated on the manufacturing sector (Barravecchia et al.,

2021), its educational applications remain underexplored despite its potential to improve service quality and institutional performance.

Haber & Fargnoli (2021) examined the customization of PSS in the medical equipment sector, emphasizing that successful PSS implementation depends on managing product life cycles and tailoring services to user needs. Similarly, Frederiksen et al., 2021 investigated strategic PSS development in the manufacturing industry, focusing on strategic marketing and business development. Their findings indicated that product–service integration enhances efficiency and customer loyalty through servitization. While Mourtzis et al., 2023 explored the use of metaverse and blockchain technologies in higher education to support collaborative learning within the framework of PSS toward the concept of University 5.0. Their study highlighted that these digital

technologies can create immersive learning environments, enabling students, faculty, and industry partners to collaboratively design and simulate product–service systems virtually. However, the study remains conceptual and has not yet been extensively tested in real university settings, underscoring the need for further research on practical implementation, technological readiness, and the impact on learning outcomes and PSS design effectiveness.

The main distinction of this study from previous research lies in its focus on adopting the PSS framework within the context of primary education, rather than in commercial or higher education institutions. This research not only examines service aspects but also seeks to formulate an integrative model that connects product elements (curriculum, facilities, learning outcomes) with service elements (guidance, consultation, learning environment) as an interactive system. Therefore, this study contributes novelty by applying the PSS concept to enhance the quality and sustainability of primary educational services. Based on the above rationale, this study aims to identify the potential for implementing the Product-Service System (PSS) in public elementary schools to enhance educational service quality, formulate a conceptual PSS model that aligns with the characteristics of public primary schools in urban settings, and provide practical insights for school administrators and policymakers in developing integrative, efficient, and results-oriented educational systems. This research is expected to offer a theoretical contribution by expanding the cross sectoral understanding of PSS and a practical contribution for public elementary schools in Indonesia to adopt an integrated product–service approach for more innovative and sustainable educational management.

## 2. RESEARCH METHOD

The research utilizes a descriptive qualitative methodology, which focuses on producing detailed descriptive information derived from verbal or written expressions of the individuals and subjects being observed (Suharina et al., 2022) with the aim of comprehensively understanding actual conditions, management practices, and naturally occurring social phenomena (Pyo et al., 2023) within SDN Kebon Kacang 05 Pagi. The qualitative approach was chosen because it enables the researcher to obtain information about behaviour, opinions and social contexts of a particular population (Oranga & Matere, 2023) not only that, the descriptive qualitative research design was selected to explore institutional conditions, managerial practices, and service development opportunities within a real-life educational context. This design allows the researcher to capture in-depth insights from key stakeholders and to interpret organizational readiness for Product–Service System (PSS) implementation, which remains an emerging concept in primary education settings. The research participants consisted of key institutional stakeholders at SDN Kebon Kacang 05 Pagi, including the school principal. A total of 1 respondent participated in this study. Purposive sampling was employed to ensure that respondents possessed sufficient knowledge and decision-making authority relevant to evaluating institutional readiness for PSS implementation.

This study carried out a systematic literature review that this approach ensures rigour, comprehensiveness, and reproducibility (Azarian et al., 2023) when assessing an existing body of knowledge. After defining the research problem outline several essential steps that structure the review process. In the sections that follow, we describe the methodological decisions taken in alignment with each of these steps (Sarasini et al., 2024). The systematic literature review (SLR) served as the theoretical foundation for this research by identifying PSS typologies, quadrant characteristics, and eligibility criteria. The findings of the SLR were operationalized into structured questionnaire indicators, which were subsequently applied in the field study. This integration ensures coherence between theoretical constructs and empirical observations, enabling informed interpretation of institutional conditions.

Data were collected through in questionnaire question where the clarity and specificity of the research question guide the selection of an appropriate qualitative method, which subsequently directs how data are gathered and analyzed (Bazen et al., 2021). Each PSS type has its own unique conceptual elements. To identify the conceptual elements covered by each business model, the respondent refers to the questionnaire that is part of their business and analyzes the data to determine the main conceptual elements that should be considered in every type of business. Once the questionnaire is completed, the potential type of PSS can be identified. Data analysis was conducted using qualitative descriptive analysis. Questionnaire responses were categorized based on PSS eligibility dimensions, including product ownership, service integration, resource sharing potential, and result orientation. The responses were then mapped against the PSS quadrant framework to identify the existing, desired, and proposed PSS positions of the institution. The identification of PSS types was conducted through an operational quadrant-mapping approach. Each questionnaire item represented a specific PSS characteristic. The accumulation of affirmative responses determined quadrant eligibility, allowing systematic classification of feasible PSS development models for the institution. The identification of PSS types was conducted through an operational quadrant-mapping approach. Each questionnaire item represented a specific PSS characteristic. The accumulation of affirmative responses determined quadrant eligibility, allowing systematic classification of feasible PSS development models for the institution.

### 3. RESULTS AND DISCUSSIONS

The results presented in this section are based on responses obtained from 1 key stakeholder, consisting of school leadership and senior teaching staff who are directly involved in institutional management and service development. This research begins with the completion of a questionnaire consisting of four main components: the existing quadrant, the desired quadrant as expressed by the business owner, the proposed quadrant formulated by the researcher, and several guiding questions designed to identify the products discussed and determine the most appropriate quadrant for business development. The results of the responses to these questions are summarized in Table 1.

Table 1. Questionnaire

No.	Question	Yes	No
1	Does your institution offer products in the form of goods or services only (without any combination)?	✓	
2	Does your institution offer products in the form of both goods and services simultaneously?		✓
3	Does your institution have dedicated human resources who are part of an expert/specialist team in the field of products offered by your institution?	✓	

4	Does your institution have human resources specifically assigned to develop software?	✓
5	Does your institution have sufficient financial resources to offer installment or leasing options? (Example: if the institution offers 6 installments per payment period, it must have reserve funds equivalent to 6× the cashflow period)	✓
6	Can the products/services provided be used by different customers at the same time?	✓
7	Does your institution have business partners who can assist in distributing the products/services provided?	✓
7.a	If question 7 is answered “Yes,” are the business partners willing to distribute the products/services using a payment per service unit method?	
7.b	Are the business partners willing to distribute the products/services in a tailored/customized manner (according to customer needs or preferences)?	

After analyzing the questionnaire results, the existing quadrant was identified, describing the status quo position of the educational institution, which falls into Quadrant 11 Pure Service. Meanwhile, the desired quadrants, as expressed by the institution, are shown in Table 2 consisting of Quadrant 3 (Advice and Consulting), Quadrant 6 (Product Renting/Sharing), and Quadrant 20 (Functional Result).

Table 2. Product Service System Desired Quadrants

Product Oriented	Use Oriented	Result Oriented
Product Related Service	Product Lease	Outsourcing
Quadrant 3 Advice & Consulting	Quadrant 6 Product Renting/Sharing	Pay Per Service Unit
Product Related Software	Product Pooling	Quadrant 10 Functional Result

Furthermore, the proposed quadrant presents the researcher’s recommendations for the most appropriate quadrants to be implemented by the institution in the future, as summarized in Table 4, Quadrant 5 (Product Lease), Quadrant 3 (Advice and Consulting), Quadrant 6 (Product Renting/Sharing), Quadrant 4 (Product-Related Software), and Quadrant 7 (Product Pooling).

Table 3. Product Service System Proposed Quadrants

Product Oriented	Use Oriented	Result Oriented
Product Related Service	Quadrant 5 Product Lease	Outsourcing
Quadrant 3 Advice & Consulting	Quadrant 6 Product Renting/Sharing	Pay Per Service Unit
Quadrant 4 Product Related Software	Quadrant 7 Product Pooling	Functional Result

Based on the quadrant eligibility mapping, the institution can develop its service and learning system through several Product–Service System (PSS) archetypes as follows:

a. Quadrant 3: Advice and Consulting

The Advice and Consulting quadrant highlights services based on expertise, where the institution functions as an advisor or mentor to other educational stakeholders. In the context of an elementary school, this may include providing teacher training, curriculum development guidance, or parent consultation programs. Through this model, the school can expand its role beyond internal teaching to become a community learning

center. According to Frederiksen (2021), advisory-oriented PSS promotes collaboration and capability building among institutions, helping schools strengthen their reputation and contribute to educational quality improvement within their networks.

b. Quadrant 4: Product-Related Software

The Product-Related Software model integrates technological tools to improve teaching and management processes. Elementary schools can utilize or develop software such as e-learning platforms, digital grade books, or parent communication systems to assist students in their learning process (Aziz et al., 2022). For example, an integrated student information system can help teachers monitor progress and provide tailored feedback. Digital-based PSS supports personalized learning (Mayub & Wardana, 2021), facilitates collaboration, and drives innovation that have positive impact in educational environments (Tunn et al., 2020), enabling schools to meet the continuously changing landscape of digital learning (McCarthy et al., 2023).

c. Quadrant 5: Product Lease

The Product Lease model provides temporary access to educational tools or technology without requiring full ownership. This can include leasing tablets, interactive boards, or laboratory kits for learning projects. The approach allows schools to utilize up-to-date educational technology while minimizing budget constraints. Leasing-based PSS models enable providers to retain ownership of products, allowing systematic maintenance and life-extension activities that reduce material consumption and environmental impacts (Saccani et al., 2024), this makes leasing a suitable for school with limited budgets but a strong need for continuous access to functional and updated equipment.

d. Quadrant 6: Product Renting/Sharing

In the Product Renting/Sharing quadrant, educational resources are shared among multiple users or institutions to maximize utilization. Elementary schools can apply this by sharing facilities such as libraries, sports fields, or science labs with neighboring schools. This approach reduces redundancy and builds community collaboration. For instance, a cluster of schools may rotate the use of art or STEM learning kits according to schedules. McCoy & Chi, 2022 noted that renting-based PSS models helps maximize resource efficiency, encourages user interaction within shared-use communities, and provides fairer access to goods for those unable to afford ownership.

e. Quadrant 7: Product Pooling

The Product Pooling quadrant emphasizes collective ownership and collaborative resource management across institutions, means other users access and utilize the product at the same time (Nyvall et al., 2023). In this model, several schools can jointly invest in and manage shared resources such as expert instructors, specialized training programs, or digital learning hubs. For example, schools in the same district could jointly hire a robotics teacher or develop a common digital platform for project-based learning. This collaboration fosters cost efficiency, innovation, and community partnership. Where pooling-based PSS strengthens sustainability and institutional networks, enabling schools to create shared value while optimizing their limited resources.

Despite the identified potential of PSS implementation, several challenges may arise, including limited financial flexibility, regulatory constraints inherent to public school governance, varying levels of digital literacy among educators, and resistance to organizational change. Additionally, the absence of formal inter-school collaboration mechanisms may hinder shared-resource initiatives. Therefore, gradual implementation, stakeholder capacity building, and alignment with education policy frameworks are essential to mitigate these risks.

#### 4. CONCLUSION

SDN Kebon Kacang 05 Pagi presents substantial potential in advancing an integrated educational service model through the adoption of a Product–Service System (PSS) framework. The quadrant mapping carried out within this research illustrates the current positioning of the institution in a pure service orientation while simultaneously revealing opportunities to shift toward more innovative and value-driven models. The analysis highlights that the school possesses readiness and strategic capacity to adopt development pathways such as advisory and consulting services, technology-enabled learning platforms, educational equipment leasing schemes, inter-school resource sharing, and pooled facility collaboration. These pathways represent meaningful opportunities to enhance institutional service delivery beyond conventional educational functions.

The insights derived from the findings demonstrate a strong alignment between the direction envisioned at the outset of this research and the outcomes identified through the results and discussion. The implementation of multiple PSS quadrants offers the potential to improve pedagogical support services, increase the effectiveness and efficiency of resource utilization, and foster broader collaborative engagement between educational institutions and their surrounding communities. This compatibility reflects that the expected benefits of exploring the PSS model in the primary school context were fulfilled and supported by the analytical evidence presented.

The implications of these findings extend toward future development prospects, particularly related to structured piloting of the recommended quadrants, evaluation of real-world implementation outcomes, and assessment of the impact on learning performance, operational management, and institutional competitiveness. Further research may also explore technological readiness, stakeholder involvement, and sustainability indicators to support scalable and long-term adoption within diverse educational settings. Therefore, the application of PSS has the potential to serve as a transformative approach for enhancing educational quality, organizational efficiency, and collaborative ecosystem building within public primary schools, especially in dense urban environments such as Jakarta. This study has several limitations. First, the research focuses on a single public elementary school, which may limit generalizability. Second, the analysis relies on qualitative perceptions rather than longitudinal performance indicators. Future studies may incorporate quantitative measures and broader institutional samples. From a theoretical perspective, this research contributes to the development of Product–Service System (PSS) theory by extending its application to the primary education sector. The operationalization of PSS quadrants in a public elementary school context enriches cross-sectoral PSS literature and demonstrates its relevance beyond industrial and higher education settings.

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