Designing Activity-based Monitoring as alternative process-based evaluation for Product-Service Systems

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ABSTRACT

Product-Service System (PSS) gives customers different offers as a type of service and product integration. PSS also provides alternative solutions to customers to meet their needs without owning a product or service. PSS is a system consisting of several entities that synergize to form value. However, a collaboration between these entities can create a level of complexity that confounds product and service boundaries, making it difficult for companies to evaluate PSS. According to a review of the PSS literature, the number of research studies discussing PSS evaluation is less than those discussing PSS design. Therefore, this article aims to initiate an evaluation design for PSS's value creation and delivery process through activity-based monitoring. In consideration, suppose a series of activities are controlled to form a specific value. In that case, the value creation and delivery processes can run according to the target. Thus, PSS can be evaluated without the need to differentiate between products and services. The design of activity-based monitoring starts with determining the PSS value, describing the activity flow, selecting activities relevant to the value, and determining the priority of the activity. The case study in this article is one of the authorized car dealers in Indonesia. The results obtained from the use of activity-based monitoring, the company in the case study can control key activities in PSS value creation and delivery.

CCS CONCEPTS

• **General and reference** → Document types; Reference works.

KEYWORDS

Product-Service System, Activity-Based Monitoring, PSS Evaluation

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1 INTRODUCTION

Product service systems (PSS) provide benefits for customers, companies, the government, society, and the environment [1]. As a result of the integration of products and services, PSS gives a variety of offerings to customers [2]–[4]. Customers focus not only on product innovation but also on service innovation offered by the organization. PSS also gives customers other ways to meet their needs without owning a product or service [4]. For companies, this condition provides space for innovation and collaboration [5]. For society and the government, the collaboration will open up new business areas supporting the country's economy [2], [4], [5]. PSS promotes closed-loop supply chain management through material recovery activities consisting of reuse, remanufacture, and recycling [6]. The material recovery activities contribute to environmental impacts, a circular economy, and a distributed economy [7]–[11]. These multi-aspect benefits increase the utilization of PSS. In addition to its industrial application, PSS has evolved into several specialized areas, including sustainable PSS [12]–[16]; smart PSS [13], [17]–[21], personalized PSS [18], [22], [23]; and so on. However, previous research that discussed ways to evaluate PSS was less important than how to design PSS with innovative and attractive features [24]. Problems often arise in evaluating PSS due to its complexity. PSS consists of several synergistic entities [25]. These entities are components that support value creation. Between components, there is the opportunity to correlate so that the performance of one component will affect the performance of other components [26]. This is a consequence of good integration between product and service. However, this interconnectedness makes it difficult to differentiate products and services as commodities offered to customers. Products and services also have different characters. Products will be related to geometry, materials, and functions [27]. In contrast, service will be connected to the actions given to customers or the nature of ownership given to customers [28]. Four service characteristics can be compared with products: intangibility, heterogeneity, inseparability, and perishability [29], [30]. The presence of integration between products and services frequently results in a mixture of hazy boundaries between aspects of the product and the service itself [31]. Thus, monitoring the value creation and delivery processes presents a company with this difficulty. Monitoring is required to ensure the company's value

creation efforts for PSS are in line with customer requirements. Consequently, it is essential to initiate research regarding monitoring methods for PSS without differentiating product performance and service performance separately, as both are a cohesive whole within a PSS. Monitoring is part of the PSS evaluation, which focuses on value creation and delivery processes. This article aims to initiate an evaluation of the value creation and delivery process in PSS through designing activity-based monitoring so that difficulties in distinguishing product and service performance can be overcome. Each activity has specific functions and outcomes that can have value. Thus, each activity has a role in value creation and delivery. If a series of activities are controlled according to the objective of forming a particular value, then the value creation and delivery processes can run effectively and efficiently.

In this article, activity-based monitoring for PSS is implemented at a car dealer in East Java. A car dealer is an example of a company that offers PSS. Besides selling cars, car dealers also provide sales and after-sales services. All three integrate and support each other in forming value. The results of this integration disguise the boundaries of products and services as the company's commodities. For example, when offering a car, the salesperson will explore customer needs so that they can suggest the car, payment methods, and car features according to the customer's profile. In addition, car dealers also provide periodic maintenance services with competitive spare parts. A series of activities experienced by customers will result in customer satisfaction. This shows that customers need a car, an effective consultation, an easy process, a comfortable atmosphere, and suggestions that match their profile. Customer satisfaction arises if the product and service performance work together to create distinct values. However, it will be difficult for companies to evaluate if they need to segregate product performance from service performance due to the complex collaboration between goods, services, and other PSS components inside an activity. Therefore, activity-based monitoring would be suitable in this case.

2 METHODOLOGY

In general, there are four steps in compiling activity-based monitoring, namely: step 1: determining the PSS value; step 2: describing the activity flow; step 3: selecting activities relevant to the value; and step 4: determining the priority of the activity. Determining the PSS value can be done by considering the voice of consumers and the interests of the company. Furthermore, these values are translated into criteria that differentiate between company activities relevant to value creation. The flowchart provides for the visualization of the sequence of value creation activities. Through the flowchart, the purpose of the activity can be identified. Furthermore, the purpose of the activity can be used to analyze the function of the activity and relevant stakeholders in value creation. This information is used to develop a strategy for managing an activity so that the outcomes are commensurate with expectations. This method is simpler than monitoring by analyzing product and service performance, which frequently blends with fuzzy boundaries. Activity-based monitoring provides information on stakeholders involved in the value creation of certain activities. Furthermore, stakeholder engagement can be developed for the common good. If the description of activities relevant to value creation is complete, potential failures in each activity are identified. This information can be used for anticipatory efforts in managing activities. Thus, there is a guarantee that activities are monitored from the standpoints of conformity with value creation and reliability with the value creation process. In this activity-based monitoring, companies must identify failures that may occur in an activity. If an activity fails, the value creation process will be disrupted. This shows the urgency to find out the probability of failure of the activity. The likelihood of failure can also be used to determine the priority of activities that must be considered. The greater the chance of failure, the greater the attention that the company must pay to prepare preventive, anticipatory, or corrective actions. Apart from failure opportunities, prioritization can be done by categorizing activities into the KANO Model. The KANO Model analysis is used to classify product or service attributes or features that affect customer satisfaction [32]. KANO is a suitable tool for translating the effect of customer satisfaction because the KANO category is identified by considering the impact of customer satisfaction when the component is in working condition and when a failure occurs [33]. Therefore, the KANO category can be used as a prioritization tool [34]. There are six KANO categories: one-dimensional, attractive, indifferent, reversed, and questionable. In the priority categories for KANO, attractiveness is considered more critical than one-dimensionality [35]. Meanwhile, "must be" is considered more critical than "attractive" by referring to the definition of the "must be" category. The "must be" category is the essential basic criterion for the product or service, or feature determining the customer's decision to leave the product or service offered in the event of failure [33]. By considering the probability of failure and the KANO category, the prioritization of activities is carried out by taking into account the occurrence and severity of the failure. The methodology in this study can be seen in Figure 1.

3 RESULT AND DISCUSSION

The car dealer in this article is one of the primary car dealers in Indonesia that has the authority to sell a well-known car brand. Furthermore, under a guise, this car dealer is labelled as an Authorized Car Dealer (ACD). ACD offers services that make it easier for customers, such as express maintenance, home service, express body painting, etc. The value to customers is related to reliability and reasonable proximity to them. While the criteria used to assess the relevance of activities to values are convenience, familiarity, and reliability. Convenience implies that every activity is simple and effective; and that customers enjoy the process. Familiarity means that customers feel close to the frontlines of the ACD so that communication can be well established. Established communication is two-way. A series of value creation and delivery activities at the ACD is presented in Figure 2.

The next stage in designing activity-based monitoring is selecting activities that align with the value conveyed to customers. The relevance assessment is based on established value criteria: convenience, familiarity, and reliability. As long as these activities can create an easy, familiar, and reliable impression, they must be adequately managed. In this case, ACD provides an assessment of the relevance of the activity by surveying the representative staff of management on December 2022. The assessment is presented by Table 1.

Table 1: The Assessment of Relevant Activity

No	Activity	Criteria	Percentage
1	Prospecting	Convenience	28%
		Familiarity	52%
		Reliability	16%
		No impression/value appears	4%
2	Visiting	Convenience	30%
		Familiarity	22%
		Reliability	43%
		No impression/value appears	4%
3	Presentation	Convenience	39%
		Familiarity	17%
		Reliability	35%
		No impression/value appears	9%
4	Negotiating	Convenience	25%
		Familiarity	25%
		Reliability	25%
		No impression/value appears	25%
5	Closing	Convenience	19%
		Familiarity	29%
		Reliability	29%
		No impression/value appears	24%
6	Delivering the order	Convenience	29%
		Familiarity	19%
		Reliability	38%
		No impression/value appears	14%
7	Maintenance reminder	Convenience	42%
		Familiarity	33%
		Reliability	25%
		No impression/value appears	0%
8	Maintenance admission	Convenience	52%
		Familiarity	28%
		Reliability	20%
		No impression/value appears	0%
9	Maintenance acceptance	Convenience	32%
		Familiarity	24%
		Reliability	44%
		No impression/value appears	0%
10	Maintenance process	Convenience	35%
		Familiarity	22%
		Reliability	43%
		No impression/value appears	0%
11	Returning the car	Convenience	30%
		Familiarity	35%
		Reliability	35%
		No impression/value appears	0%
12	Following up	Convenience	38%
		Familiarity	46%
		Reliability	17%
		No impression/value appears	0%

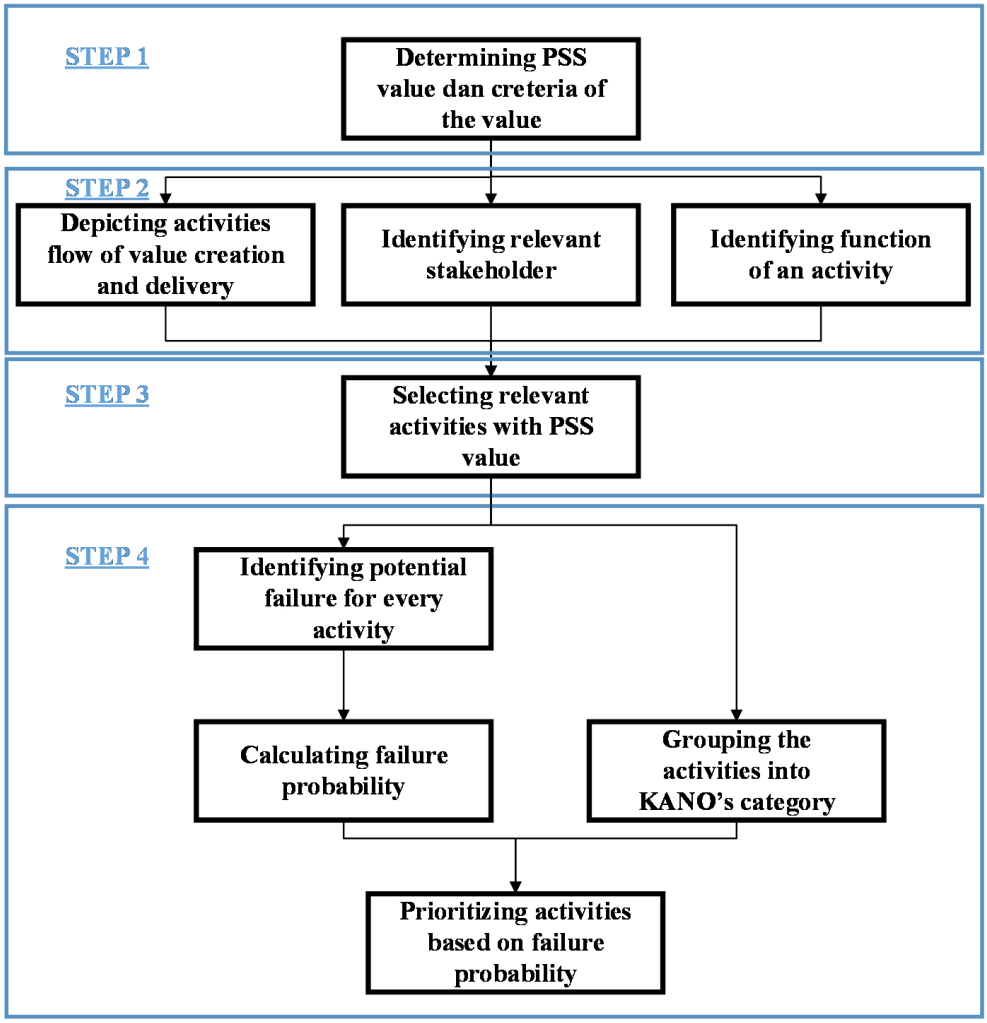

Figure 1: The steps of designing the activity-based monitoring

Table 1 shows that all activities in ACD are relevant to the PSS value, so all activities are designed to influence value creation. The implication is that ACD can create a series of meaningful and synergistic activities to add value from the first customer interaction to a long-term relationship. For example, prospecting activities can contribute to value creation through the impression of convenience (28%), familiarity (52%), and reliability (16%). However, only 4% of the representative staff of management considered that prospecting activities contributed to PSS value. An activity is considered to not contribute to the PSS value if more than 50% of assessors state that no relevant value arises from the activity. The point that can be discussed is how to design a series of activities that strongly impact value creation by taking into account the benefits obtained and the capabilities of the company. An analysis of the activity's ability to form a value can be used to cut activity waste. This wasteful activity must be eliminated, even if it can please customers. The elimination of wasteful activities can be a source of company savings. The key word in activity elimination is contribution to value creation. The value the company wants to convey can be measured by customers who provide feedback to facilitate the improvement and innovation of more practical activities.

Activities relevant to values must be maintained to run well and are by the objectives. Therefore, it is necessary to identify and assess the probability of failure in each activity based on historical data. In addition, companies can also determine the effect of customer satisfaction by categorizing these activities into the KANO category. The implications of the KANO category for value-creation activities are as follows:

- If an activity is categorized as "must-be (M)", it must not fail because it can cause a loss of customers.
- If an activity is categorized as "attractive (A)", that activity is something that can attract customers to use the offered PSS.
- If an activity is categorized as "one-dimensional (O)", the activity is necessary for the customer, and the level of satisfaction is proportional to the performance of the activity.

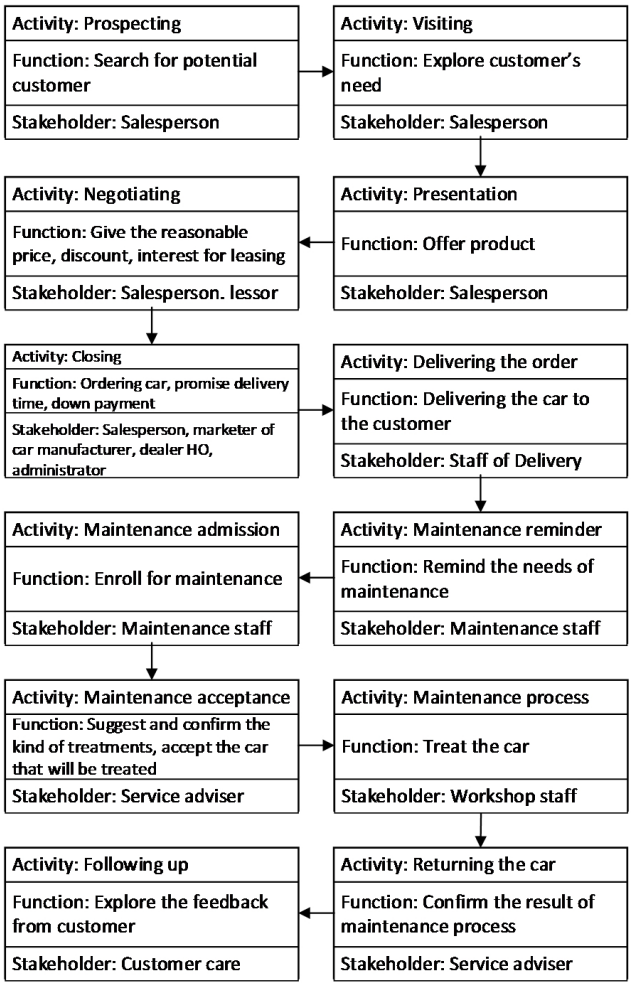

Figure 2: Value creation process flow

- If an activity is categorized as "indifferent (I)", it won't have a satisfaction effect if it goes well, but it won't have a dissatisfaction effect if it goes badly.

Based on these implications, the weights of the KANO categories for must-be, attractive, one-dimensional, and indifferent are 4, 3, 2, 1. This weight is then used as a multiplier for the probability of failure, which can be used as the basis for prioritizing activities in the monitoring process of value creation. The processing results are presented in Table 2.

Priority numbers can be considered to find key activities in value creation. The higher the priority number, the more critical the role of activity in value creation. The priority number reflects the occurrence and severity of the failure. Suppose historical data shows that failures occur frequently. In that case, the company must provide treatment so that the activity can work appropriately and the desired value can be delivered to the customer. Likewise with severity, the dire consequences that arise if a failure occurs need to be anticipated. Based on Table 2, the three highest priority numbers that can be used as key activities in value creation are negotiation, maintenance reminder, and prospecting. Negotiation activity is a crucial and memorable activity for the customer; this negotiation can have an impact on the customer in the long term, such as determining interest rates and terms for leasing. The KANO category is also included in the "must be" category, where failure to carry out activities can result in loss of customers. This long-term impact has a strong influence on value creation. Maintenance reminders are also included in activities that can make a strong impression on customers. In addition, maintenance reminders can also be used to build sustainable relationships. Customers do not need to remember maintenance schedules because the company provides these services properly. In line with negotiations, prospecting is also a crucial and memorable activity for customers. Customers also feel the results of prospecting in the long term. Ways to prioritize activities can be used as a discussion point for future research. In the case of multi-criteria decision-making, several other ways of prioritizing activities can be carried out [36]. In this case, the method of prioritizing activities is carried out by adopting a risk management process that considers the occurrence and severity of failure [37].

In addition to determining how to prioritize activities, choosing the number of feasible activities can also become a discussion point for future research. In this case, the next step in maintaining the three key activities above is to analyze the PSS components associated with failure. Five PSS components can be interpreted as sources of failure, namely products, services, actors, stakeholder relationships, and technology [26]. An example of unsuccessful negotiation activity is salespeople's failure to find common ground between company interests and customer expectations. The failure will be related to sales (the actor) and sales approaches to customers, companies, or other parties (stakeholder relationships). Companies can carry out failure control by building skills and knowledge through sales. In addition, companies can explore the difficulties faced by sales when approaching customers, other companies, or other parties. Thus, negotiation activities can run smoothly and contribute to value creation. Furthermore, key activities can be controlled by setting appropriate key performance indicators (KPIs). This is consistent with previous research on performance-based PSS evaluation [38], [39]. The effectiveness of result-of-performance-based evaluation can be used as a discussion point for future research. Furthermore, determining integrated KPIs for evaluating PSS and company performance can also be used as a discussion point for future research.

4 CONCLUSION

Activity-based monitoring to evaluate PSS has provided convenience by keeping the value creation process simple without regard to product and service integration complexity. The monitoring process is approached through visible and impactful activities for value creation. Activity control is also carried out on a results-based basis so that it still pays attention to expectations for PSS. Thus, the value creation and delivery process to customers goes according to plan. The design can bring together customer expectations with the interests of the company. The implementation of activity-based monitoring in PSS also assists companies in determining key activities in value creation. In this case, three of the twelve activities are key in value creation: negotiation, maintenance reminders, and

Table 2: Key Activities for Value Creation Based On Priority Number

No	Activity	Failure	Probability of failure (%)	KANO		Priority Number	Ranking
				Category	Weight		
1	Prospecting	Salespeople does not have a reliable data source	30	O	2	0,6	3
2	Visiting	Salespeople do not understand customer needs for car variants	20	O	2	0,4	4
3	Presentation	Salespeople do not master the product knowledge	20	O	2	0,4	4
4	Negotiating	Salespeople do not find common ground between company interests and customer expectations	20	M	4	0,8	1
		There was miscommunication between salespeople and third parties (such as leasing parties, samsat, car variation parties)	10	M	4	0,4	4
		Salespeople fail to offer attractive service to customers	20	O	2	0,4	4
5	Closing	Salespeople do not find common ground between company interests and customer expectations	10	M	4	0,4	4
		There was miscommunication between salespeople and third parties (such manufacturer, other dealer and Head Office)	10	M	4	0,4	4
6	Delivering the order	There is a car discrepancy related to what was promised (bonus or quality)	10	M	4	0,4	4
		There was a delivery error (place or time)	10	M	4	0,4	4
7	Maintenance reminder	There was an error sending the message to the customer	10	M	4	0,4	4
		There was a delay in receiving messages to customers	20	M	4	0,8	1
8	Maintenance admission	A registration error occurred	5	M	4	0,2	13
		Error registration system	2	M	4	0,08	14
9	Maintenance acceptance	The staff is unable to identify the type of care needed	2	M	4	0,08	14
10	Maintenance process	Spare parts are not available	2	M	4	0,08	14
		There are no reliable tools available for the treatment process	1	M	4	0,04	17
		The technician is unable to solve the problem	1	M	4	0,04	17
11	Returning the car	The staff does not convey the results of the treatment process clearly	1	M	4	0,04	17
12	Following up	Staff does not explore a feedback properly	1	M	4	0,04	17

prospecting. Determination of these key activities by considering the occurrence and severity of failures that may occur in each activity. Based on the research in this article, several topics of discussion that could be used as future research include the ways to prioritize activities and to choose the number of feasible activities, the effectiveness of result-of-performance-based evaluation related to activity-based monitoring; and the framework to determine integrated KPIs for evaluating PSS and company performance as well. However, the benefits of this research can be increased through a comparative study of the application of the methodology presented

in Figure 1 in different case studies so that the potential for varied results can be studied more thoroughly. In this study, Figure 1 shows a methodology initiated generically, but each industry's types and risk priorities will differ.

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