Supporting the Performance Assessment of Product-Service Systems during the Use Phase

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Abstract

Companies providing Product-Service Systems (PSS) can gain competitive advantages by addressing the customer needs in a more precise way than regular product manufacturer. However, achieving these benefits also increases the responsibility on the company’s side because the value of a PSS is delivered during the use phase. In many cases a provider stays the owner of the PSS and is thus responsible for the performance during the use. Accordingly, the PSS provider acts not only as a manufacturer but also as a service provider, which requires a constant monitoring of the PSS performance (e.g., service availability or customer satisfaction). The implementation of a performance measurement system is an approach to cope with the additional responsibilities during the use phase. However, different publications exist that offer support for the development phase of PSS but the performance assessment during the use phase is not addressed sufficiently, even though the importance in mentioned by different authors. This paper thus proposes two generic processes to address the identified need for the performance assessment of PSS. The first process guides through the implementation of an entire performance measurement system, and the other process describes the development of PSS specific key performance indicators (KPIs). The proposed approach applies KPIs to a new context and supports PSS providers in implementing a performance measurement system, which allows them to initiate measure to increase the PSS performance.

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1. Introduction

Product-Service Systems (PSS) are a combination of a tangible product and an intangible service [1]. Tukker [2] identified three different types of PSS: 1) product oriented services offering PSS related advice and consultancy 2) use-oriented services allowing product lease, rent, or pooling, and 3) result-oriented services determining the desired outcome for the customer.

Linking product and service offers gives companies the opportunity to increase their competitiveness by shifting the company’s attention to the final customer demand. Therefore, offering PSS facilitates companies in creation additional value for their customers (e.g., reduced costs, or fewer in-house competencies) [3]. However, the additional competitive opportunities facilitated through PSS offerings lead to new challenges for companies like the extended producer responsibility due to the fact that the value of PSS is delivered during the use phase [4]. Therefore, offering PSS requires a shift in the role of a company, from a manufacturer of a product towards a provider – not only offering a product, but also services to the customer. The value for the customer no longer lies in the ownership of the product, but rather in the performance of the PSS during utilization (e.g., product and service availability, response time, or maintenance). Therefore, the company’s attention should also focus on the use phase of PSS. Assessing the performance means in general a relative evaluation of the achievement of defined objectives [5].
Providing successful PSS requires the consideration of the entire life cycle of PSS because of the connection to the product, and the ownership that often remains after delivery [6].

A literature study on existing publications in the field of PSS reveals that further attention should be given to the development of additional support for the use phase. The assessment of the performance of PSS during the use phase is described as an important aspect. However, the need is addressed unsatisfactorily because many existing approaches concentrate on the design phase instead of supporting the use phase or the entire life cycle of PSS or [7].

The objective of this paper is to address the identified need and to provide an approach that helps PSS providers to assess the performance. The use phase is of special interest because important information can be gathered concerning the performance of the PSS. Collecting such information offers great potential for PSS providers from two perspectives. First, it assists in identifying potential for improvement regarding the current PSS. Secondly, it facilitates the generation of knowledge for future PSS development and helps to address the user’s needs more precisely [4].

Based on a literature review an initial approach is presented which supports the development of performance measurement system. Key performance indicators (KPIs) have been identified as a suitable method to assess the performance of PSS during the use phase. The developed approach is a first step towards supporting PSS providers to monitor the performance during the use phase and to derive measures based on the gathered insights.

2. Methodology

This paper is part of a larger research project within a collaborative research center focusing on the analysis of the cyclic interactions in PSS during the use phase.

Figure 1 depicts the research methodology and its four separate steps, which were conducted for this paper. The first step is an initial literature review focusing on the challenges that exist during the use of PSS. The results revealed that performance assessment during the use phase of PSS is an important aspect for providers because the customer value is delivered during use. However, generic approaches that support the actual assessment of the performance of PSS are missing.

![Figure 1. Overview of the research methodology](image)

Figure 2 illustrates that the service part of a PSS also leads to a different life cycle perspective from a company’s standpoint. Besides the regular product life cycle, the customer relationship life cycle needs to be considered as well by a provider of a PSS.

![Figure 2. The two life cycles of a PSS](image)

The second and third steps were conducted simultaneously and analyzed the discovered needs in more detail. The objective was to clarify what type of support is required for the use phase and to outline alternatives for performance assessment based on detailed literature study. The last step uses the insights from the previous steps to address the identified need for a performance measurement system with the existing methods for performance assessment. The outcome of step four is an approach supporting PSS providers in deriving a performance measurement system consisting of different KPIs, enabling performance assessment during the use phase.

3. State of the Art

The following chapter summarizes the findings of the detailed literature study. The initial analysis of existing work revealed that a performance assessment during the use phase is an important task for PSS providers. However, a lack of suitable approaches to support this task was identified.

To address the need in an adequate way, the first part focuses on existing use phase support for PSS and the requirements for a methodological support. Afterwards, existing possibilities to assess the performance of organizations and projects though indicators are presented.

3.1. Use Phase Support for Product-Service Systems

Offering PSS to customers can lead amongst others aspects to economic or environmental advantages [8]. Achieving these improvements implies overcoming new challenges that are connected with the concept of PSS. A main aspect that must be kept in mind is that the delivered value for the customer is a combination of a product and its corresponding services [9].

As a result, providing PSS requires that companies enlarge their perspective from being a purely product driven company, towards also considering the service component.
consumption phase of a service [11]. Thus, the use phase becomes of greater importance for the success of a PSS compared with a normal product manufacturer.

The additional responsibility for a PSS provider during the use phase not only requires a change in thinking but also the application of new tools and methods. First, defining a set of achievable objectives and establishing clear service strategy is an important step towards being a successful PSS provider [12, 13]. The key to the successful development of a PSS strategy is to build up a clear understanding about the requirements and customer value [14]. After defining objectives and a service strategy, it is of great importance to set up a performance measurement system [6, 15]. Therefore, offering a PSS implies that the provider takes over the responsibility in monitoring the performance during the use phase [4]. Being in charge of this new task requires that the PSS provider implements new methods to ensure that the efficiency, quality, and delivery time of provided services are within the customer’s expectations. The additional task concerning the performance measurement should not be seen as a burden, but rather a chance to constantly improve the PSS [6, 15]. The close contact with the customer during the use phase allows PSS providers to build up a better understanding of the related customer needs and requirements, which should be used in the future for enhancing the PSS.

The service component of PSS requires an iterative process during the use phase that consists of two main blocks: (1) service development and (2) service management [16]. Ramaswamy argues that the performance of delivered services needs to constantly exceed the customer’s expectations to be successful. Accordingly, an iterative process is required that includes not only the development of a service, but also the service management. This is facilitated through a performance measurement system aimed to derive improvements.

Overall, monitoring the performance of PSS during the use is an important aspect providers must incorporate because they need to ensure that the promised customer value is delivered during the use phase and that the objectives are achieved.

### 3.2. Performance Assessment

Managers and decision makers face increasing complexity in their daily business. Nevertheless, it is important under such circumstances to constantly assess the performance of a company in order to ensure that transparency is accomplished, and to which degree the defined objectives are achieved. Facilitating an assessment of the performance and a handling of complexity, is attained through the definition of metrics.

The basic idea driving the implementation of performance metrics or indicators is “what gets measured gets done” [17]. In general four different types of performance measures can be identified: Result indicators (RIs), Performance indicators (PIs), Key performance indicators (KPIs), and Key result indicators (KRI).

These four types of indicators can be divided into two groups: (K)RIs and (K)PIs [18]. The (K)RIs serve as past oriented indicators describing to which degree the company achieved its defined goals. These indicators are evaluated over longer time intervals. In contrast, (K)PIs are current or future measures and indicate what needs to be done in order to increase the current performance to achieve the defined objectives. They are non-financial indicators and tie down responsibility to the team to take appropriate action. Therefore, KPIs should encourage the respective stakeholders to initiate suitable measures in response to the situation that arises. KPIs should be evaluated daily or at least weekly.

In practice, companies should use and implement a mix of different types of indicators [19]. Such a mix of different performance indicators is called a performance measurement system. KPIs in particular are linked to objectives, which are especially important for current and future success.

Applying an indicator based assessment of the performance offers a number of advantages for companies. If the indicators are defined and applied correctly, it is possible to identify issues early on, allow for informed decisions, enable future estimation, and foster proactive management [18].

To overcome problems with the definition of correct KPIs, a set of five criteria exists [20]. Literature refers to those criteria often as SMART: Specific, Measurable, Attainable, Realistic, and Time sensitive. KPIs that comply with these five criteria allow companies to assess their real time performance and to define measure early enough before severe problems occur. Aside from the opportunities that KPIs offer, it is also important to talk about the disadvantages. Evaluating KPIs also means effort to ensure a frequent evaluation. As a result, it is important to compare the value of an indicator with the effort required for the evaluation [17]. Furthermore, the number of indicators should be limited to ensure a meaningful overview of the current situation. Parmenter [18] suggests the 10/80/10 rule, meaning: 10 KPIs, 80 PIs and RIs, and 10 KRI.

### 3.3. Need for a Performance Measurement System

The objective of this section is to summarize the outcome of the detailed literature review and to derive implications concerning the required support for performance assessment of PSS during the use phase.

Being a PSS provider implies a shift in the company’s role towards a service provider, requiring the definition of a service strategy including objectives and the constant monitoring of the performance. Therefore, not only a change in thinking is important but also an adaption of the used tools. The outcome of the literature review in Section 3.1 shows that performance assessment during the use phase is important in order to ensure that user needs are addressed correctly, the promised value is delivered, and that the objectives are achieved.

Although various publications mention the importance of performance assessment many of the existing methodologies focus on the development phase and not on the use phase of PSS [7]. Vasantha et al. points out that among other aspects, the monitoring during the use phase is not addressed sufficiently enough in existing methodologies for PSS.

The third step of the research methodology in Section 3.2 evaluates methods for performance assessment. The discussion points out that defining performance indicators is a promising approach for the implementation of a monitoring system. KPIs are a suitable method to monitor the achievement of objectives and to identify the need for measures. However, most companies apply KPIs to assess the performance of projects of
the organization [21]. Using KPIs in a new context in order to assess the performance of PSS during the use seems promising because it allows providers to constantly monitor the PSS and make decisions based upon the available information.

Overall, the literature review revealed that the performance assessment during the use phase is an important topic to address. However, existing methodologies do not offer sufficient support on this matter. This paper aims to address this identified need for a PSS specific performance assessment system and to provide a methodological approach to monitor the performance during the use phase.

4. Performance Assessment of Product-Service Systems

The objective of this chapter is to address the identified need for performance measurement systems for PSS during the use phase. Based on the outcome of the literature review, KPIs serve as a suitable possibility to assess the performance. However, no approaches exist that apply KPIs to assess the performance of PSS during the use phase. Therefore, the objective of this paper is to present an initial and generic approach that supports PSS providers in developing and implementing a case specific performance measurement system. The approach is designed to especially support use and result-oriented PSS because of the increased service component, which leads to a higher responsibility during the use phase.

4.1. Performance Measurement System Implementation

Based on the identified need for a performance measurement system, the objective of this paper is to offer a generic approach that can be applied to different PSS. As a result, a systematic approach that guides through the implementation of a performance measurement system for PSS during the use phase is needed. Bourne et al. [22] argues that the implementation of a performance measurement system is conducted in three phases: Design of performance measures, implementation of performance measures, and use of performance measures.

Figure 4 illustrates the proposed process for the implementation of a performance measurement system for PSS. The presented process is based on the three general steps mentioned above. However, further detailing was done to develop a process that respects additional challenges in the implementation of KPIs. The first step of the proposed process focusing on the development of specific KPIs will be discussed in detail in Section 4.2. Step two focuses on an important task that prepares the implementation of a performance measurement system. Without defining a reporting structure, a performance measurement system will not function properly [18]. During this step the person who is evaluating the KPIs, the frequency of evaluations, and the way how the results are visualized, all need to be defined. These decisions are needed to ensure that someone is held accountable for the performance measurement system, otherwise no measures based on the KPIs are initiated.

Afterwards, the developed performance measurement system is implemented. During this step the developed KPIs must also be tested under real conditions before their integration in business processes and use for decision-making. The forth step deals with the evaluation and utilization of the defined KPIs. It is important to mention that implementing a performance measurement system is an iterative process requiring a periodic audit of the defined KPIs to ensure that internal and external changes or additional insights get respected [17]. Depending on the results of the audit, the definition of new KPIs or other adaptations of other aspects might be required.

4.2. Development of Performance Measures

The previous section introduced a process for the implementation of a performance measurement system. Based on the forgoing explanation of the process, the focus is now to discuss the development of KPIs in more detail.

Figure 5 illustrates the proposed process to support the development of KPIs for PSS use phase assessment. It is important to mention that the focus of the paper is on the second part of the process. The first part summarizes the basics steps suggested for the development of PSS. Those steps are discussed in more detail in other publications [10, 15].

The idea behind depicting not only the core process for the development of the KPIs is to clarify how the performance measures are connected to the decisions made during development of a PSS and the pursued strategy. The main input for PSS are the requirements that are derived from the customer needs and the objectives of the provider. Furthermore, external factors – such as available technology or competitive situation – influence the requirements. The developed PSS serves as the main input for the development of the specific KPIs. Due to the fact that PSS consist of a product and services, the operations strategy needs to consider both aspects [23].

The next phase is to derive specific KPIs based on the service and product strategy of the developed PSS. In many cases the underlying strategy of a PSS covers different aspects (e.g., repair, customer satisfaction, maintenance, or customer acquisition). Therefore, critical success factors (CSFs) should be used to derive KPIs from the strategy for the PSS [18]. CSFs can be defined for different levels within a company and should represent aspects or goals that are of great importance for the overall success [24]. Accordingly, the number of CSFs should be limited to five to ten in order to ensure that the focus is only on the critical aspects. Important note to mention is that CSFs
are aspects that cannot be measured in contrast to KPIs. An example of CSF of a PSS provider could be to “ensure high availability of the services”. The corresponding KPI could be “keep the downtime of the service under 5%”. This example points out the differences between CSFs and KPIs. CSFs help to extract the crucial aspects of the PSS strategy that determine the PSS performance. Every KPI should be at least connected with one CSF to ensure that all important aspects are incorporated in the performance measurement system.

The development of a performance measurement system should be done in workshops together with employees representing the different functions involved in PSS development and management. Parmenter [18] suggests a workshop concept that can help to identify CSFs and KPIs. An important aspect when it comes to developing KPIs, is that the management supports the implementation process without any exceptions because employees need authority to decide about measures based on the KPIs.

For the development of KPIs supporting the monitoring and assessment of the performance of PSS during the use phase, it is important to achieve a balance between the company and customer oriented performance measures. As discussed earlier, offering a PSS requires a shift in the strategy towards a service provider. Therefore, KPIs should not only focus on the business success (e.g., number of new customers or sales volume) but also the service aspect (e.g., number of customer complaints, downtime of the service, or response time). Due to the fact that the value of a PSS is delivered during the use, providers should incorporate the additional responsibility during the use phase in the performance measurement system.

The proposed process for the development of KPIs is embedded in the process for the implementation of an entire performance measurement system as depicted in Figure 4. Accordingly, the process for KPIs development also has an iterative character like the one for the implementation of the performance measurement system. Using and developing KPIs does not only require a frequent evaluation of the indicators but also consideration of the dynamic environment PSS and providers are interacting with.

5. Discussion

The discussion of the detailed literature review in Section 3.3 revealed the need of a performance measurement system that supports PSS providers to monitor the delivered performance during the use phase. Based on the identified need for additional research two processes were presented in the following that help providers of PSS to implement a performance measurement system based on KPIs. Neely [25] mentions that companies should evaluate the performance to obtain a clear picture of the current status and the progress achieved, to confirm the priorities that are important for success, and to trigger constant improvement. However, KPIs and a performance measurement system can help to increase the performance of a company though more is required than just defining KPIs [26]. The performance measurement system needs to be embedded in a system that not only assesses the performance but also decides about measures.

Using a performance measurement system can help providers to gain further insights about the use of PSS, allowing them to either improve current PSS or trigger innovation of future generations. Developing and implementing KPIs thus offers the opportunity to constantly improve PSS and to increase the delivered value for the customer. Nevertheless, KPIs and other performance indicators do not deliver all benefits from the beginning. After the implementation of a performance measurement system, experience must be gained to understand how the different indicators need to be interpreted.

6. Conclusion and Outlook

The literature review revealed the importance of a performance assessment during the use phase to trigger measures enabling a constant improvement of products and services. However, different publications only mentioned the importance of performance assessment with no general process being found of how performance measures can be derived systematically for PSS.

This paper introduced two processes that support the implementation of a performance measurement system for PSS. It was decided to use KPIs for the performance assessment because they allow a fast situational reaction and are oriented towards future success. Implementing a performance measurement system is an iterative process that requires the definition of a reporting structure and
responsibilities. Regular audits should be performed to adapt the defined KPIs if necessary.

The second process focuses on the development of KPIs based on the operations strategy for the PSS. Applying CSFs helps to identify and link the critical aspects of the PSS strategy to the corresponding KPIs. The discussion revealed that the performance measurement system needs to be embedded in the company to ensure correct functioning and constant improvement.

Implementing a performance measurement system to assess the performance of PSS seems to offer the potential to overcome challenges providers phase during the use phase of PSS. The approach to apply KPIs to assess the performance of PSS during use phase is new. Therefore, an important step for the future is to apply the proposed processes within a case study to evaluate the usefulness of the developed approach. In the future, the potential of KPIs should be evaluated to support the design process when embedded in dynamic simulation models. In addition, it should be analyzed how KPIs can be used systematically to trigger improvement of current and future PSS from a provider’s perspective.

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