Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 64 (2017) 336 – 339

www.elsevier.com/locate/procedia

The 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems

Approach to test a Product-Service System during Service Engineering

Mike Freitag[a*], Christian Schiller[b]

[a]*Fraunhofer IAO, Nobelstr. 12, 70569 Stuttgart, Germany*
[b]*Universität Stuttgart, Institut für Arbeitswissenschaft und Technologiemanagement, Nobelstr. 12, 70569 Stuttgart, Germany*

* Corresponding author. Tel.: +49 711 970-5105. *E-mail address:* mike.freitag@iao.fraunhofer.de

Abstract

Service testing is becoming more and more important for manufacturing companies nowadays. Testing services before market launch helps to avoid mistakes and unnecessary costs. The test phase of new service development has often been neglected in business practice, but more and more its value is being fully recognised. A focus of this paper is the development of a new scientific testing approach of product-service bundles and product-service systems. The new model considers not only the service but also the product component. It is shown that there are different possibilities to combine new product and new service development – for example, products and services can be developed separately or in an interactive or integrated way – and that it is in the test phase that both components could be tested under realistic conditions before the market launch. Thereby the importance of the test phase during the development process of product-service bundle is emphasised.

Peer-review under responsibility of the scientific committee of the 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems.

Keywords: service testing; product-service; product-service system; new service development;

1. Servitization in manufacturing companies

Servitization for manufacturing companies becomes more important in order to find new markets or customer [1,2,3]. Traditional product-oriented companies change step by step to being more service-oriented. This is a grand challenge for every company, for their products, services and employees. This changing process is often referred as the servitization. However, the servitization is not just a change in the business model: It involves all the aspects of the enterprise, which therefore needs methodological and technical support concerning an integrated development [4] and management of a Service Lifecyle Management [5,6] which covers the Service Engineering [7,8,9] and the Service Operations phase [10, 11] as well the interactions to the Product Lifecyle Management [12,13].

Services are complex behavioural phenomena that can be quite difficult to understand and describe. The service market has been becoming more and more dynamic in recent years. In this kind of increasingly competitive environment, high quality, low cost, and technology leadership are not enough to provide a competitive advantage for companies; therefore, many are trying to differentiate themselves by developing innovative product-service systems in order to reach a unique selling point.

2. Test phase in different approaches of new service development

If a comparison is made among different new service development approaches, it is quickly revealed that most process models also include a test phase. But in most cases, the test phase is not described in detail. An exception is the process model by Burger [14], but even this approach has some weaknesses: for example it does not consider a product component, which is essential in testing of product-services bundles. Below, a short description of each of the compared models is provided.

Sakao and Shimomura [15]: The structure of this model is slightly different from those of the other models considered in this chapter. First, a so-called flow model with scope models for the relations between different participants in the service

Peer-review under responsibility of the scientific committee of the 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems.
doi:10.1016/j.procir.2017.03.059

process has to be generated. In the next phase, a persona (a template for a persona and an example are shown in the appendix) for a service receiver has to be generated and important state parameters described. After the completion of this phase, the concept development can be started. The concept development is divided into two phases: the description of the value and the generation of a realisation structure. Instead of a test phase, this model offers a phase called 'modifying the flow model'. Here, the preliminary flow model is modified and a design solution generated.

Burger, Meiren & Kim [14]: This new service development model entails applying appropriately modified engineering know-how from the field of conventional product development to the development of services. The overall development is subdivided into six broad phases: idea management, requirements collection and analysis, concept development and service design, service testing, implementation, and market introduction. It has a practical value and makes explicit reference to tools and methods that could be adapted easily to the new service development process.

The main feature of Freitag's [5,6] model is the transposition of the testing and implementation phases. The model focuses on IT services like smart services. Each phase is given three modules, whose performance is explained in detail: 'Simulation Virtual Lab', 'Business Assessment', and 'Technical Assessment'. A service can be tested by analysing the interaction between two or more people in a virtual lab, or by checking the business model or the hardware or other technical equipment [5,6].

The model of Ojasalo [16] describes a kind of lean service development. It emphasises the importance of rapid testing and learning in an iterative service development process. The model consists of the following phases: need and problem identification, solution idea(s), solution design, experimenting and testing with users and other stakeholders, evaluation, possible implementation, and possible abandonment. The main part of this model is the 'rapid testing and learning loop', which refers to the phases of solution design, testing and experimenting with stakeholders, and evaluation. These phases can be repeated several times depending on the results.

3. Framework for testing of Product-Service System

This section focuses on a framework development for testing product-service systems. The framework shown in the following subchapters is based upon the approaches from [5,13] and [14].

3.1. Process model development

The fact that traditional process models for service testing are more focused on the service component does not mean that the product component is completely unconsidered. The product is often part of the service process, defining the service environment (servicescape) or affecting the interaction design. In contrast to this, there is a deeper involvement of products in product-services and product-service systems.

Product-Service System (PSS): It is a system producing a mix of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs. The key components of a PSS [17, 18] are:

- The System as a set of elements and their relations producing the product and delivering the service to the customer.
- The Product as a tangible commodity manufactured to be sold fulfilling user's needs or supporting the creation of a service.
- The Service as an activity done for the stakeholders with an economic value, with intangible results …"

In the test phase of product-services and product-service systems, the interaction of the service component and the product component has to be considered under realistic conditions. The test can have four possible results:

- Both the service component and the product component are accepted for implementation.
- The service component is accepted and the product component is not accepted for implementation.
- The service component is not accepted and the product component is accepted for implementation.
- Neither the service component nor the product component are accepted for implementation.

Figure 1 provides a visualisation of the possible results.

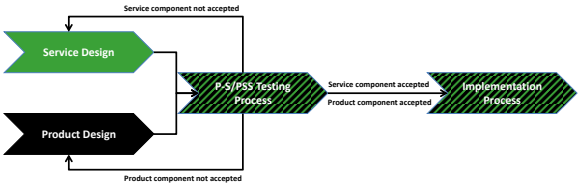

Figure 1: Global view of the test phase of product-services and product-service systems

The basis for a successful implementation and market launch of a new product-service or product-service system is the acceptance of both the service-related and the product-related results. If one of the two parts is not applicable for a market launch, a second loop of (re-)design and testing is necessary. This leads to a more iterative approach than with simple product or service testing, because either component could initiate a second iteration.

3.2. Steps for testing product-services and product-service systems

The contents of this chapter further elaborate the service testing approach from Burger, Meiren & Kim [14]. The process model of this approach is also shown in Figure 2.

Figure 2: Service testing approach from [14]

The model describes the test procedure more in depth whereas the framework from chapter 3.1 gives a more global overview about the placing of the test phase in the whole development process of PSS. In Figure 3 the correlation between the process model of service testing and the framework from Figure 1 is visualized.

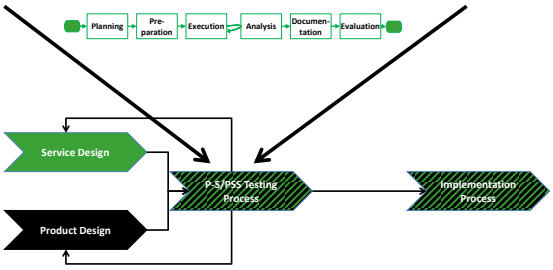

Figure 3: Integration of the service testing process model into PSS Engineering framework

Because the main focuses of this article are product-services and not only services some adaptations in the process steps are necessary. They will be annotated in the following section.

The process model for testing product-services and product-service systems consists of several different steps. The first steps are addressing the planning and preparation of the test environment, objects, subjects, processes etc. After the execution of the test, an integrated analysis is necessary. This analysis leads to results on the service component and the product component. In the following, the different steps of the process model are also described in Figure 4.

The first step of the test phase is the **planning**, where the persons responsible for the service component should be determined. On the product side, the technical aspects have to be determined, and, similarly to the service component, the individuals identified who will be responsible for performing the test. Further, a test concept has to be established, defining which functions of the product and which functions of the service should be tested. The interfaces and all possible weak points of the product-service or the product-service system have to be identified. The requirements for successful test performance have to be defined, as well as how the determined target group could be simulated in the test phase; e.g. should the test be executed by real or fake customers? Is it sufficient to test only digitally with the help of software tools? The planning of the test phase has to be done in an integrated way.

If the concept is known and the planning step completed, then the **preparation** of the prototypes can start. This means the provision of relevant products or prototypes, as well as the delivery of context-specific know-how on the product side, and analysis of processes and provision of the test environment, service-related subjects and objects, and interaction design on the service side. For the interaction design, different methods are available, e.g. personas, empathy maps, or role concepts. Delivery of context-specific know-how is also necessary in this phase. The preparation of service and product should be done interactively.

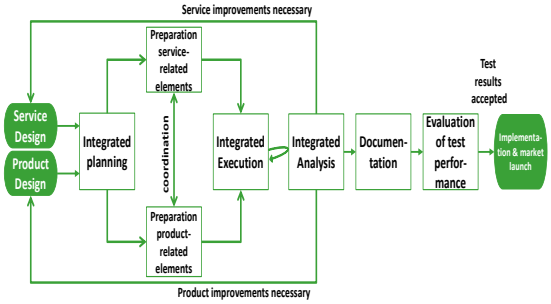

Figure 4: Process model for testing Product-Services Systems

In the **execution** step, service and product activities have to be performed under such realistic conditions as possible. All testing of services and interaction activities will be performed together with the relevant product(s). Important in the execution step are detailed observations and data collection (e.g. by product-integrated sensors) to allow a detailed analysis of the product-service or product-service system in the next step, and identify possible inadequacies. With the completion of the execution step, the active testing of service and product performance will be finished. The further steps are the analysis and documentation of the test results, and, at the end, the evaluation of the test performance.

The **analysis** step comprises a thorough examination of the gained data and feedback. Furthermore, possible improvements will be defined. Depending on the results, there are different possibilities for the further process. If the results for the service component and for the product component are applicable for market launch by the responsible persons, the implementation process can start. Otherwise, the service part, product part, or the whole system will have to be adjusted or completely revised.

When the analysis is completed, the results need to be recorded in a **documentation** process. This should include both the test results and the identified suggestions for improvement. The latter should be combined with an action plan to integrate the improvements into the product-service or product-service system. It has to be taken into account that the service-related elements, the product-related elements, and the overall product-service or product-service system all have to be considered.

The last step is to **evaluate** the performance of the test procedure towards a continuous improvement process (CIP). Evaluation can be carried out through collection of detailed feedback from the test participants. A final test report should then be created.

4. Validation

The validation for the test approach for a Product-Service System is a service to test a new furniture in buildings. For the testing process, prototypes of different virtual office environments have to be created. The prototypes have to be modeled in the software Unity VR. Considering the office

layout, two to three different options should be prepared for each office environment. For instance, colours or materials can be varied for chairs, desks, and cupboards. This gives the customer the opportunity to compare and evaluate a defined set of furniture for each office. For a structured evaluation, it is also necessary to develop a prototypical assessment tool for customer preferences which is easy to handle during the VR session. This can be realised in different ways, e.g. using virtual annotation or a rating system based on credits. During the test phase, the results for the method with the highest feasibility and user friendliness should be checked. This evaluation has impact on the service design of the usability of the VR-service and as well on the product design of the furniture. At the end a Product-service system is developed which allows to visualize, to select and to evaluate new furniture in office buildings.

5. Summary

A focus of this article is the development of a new scientific testing approach of product-service in the development phase. The new model considers not only the service but also the product component. It is shown that there are different possibilities to combine new product and new service development – for example, products and services can be developed separately or in an interactive or integrated way – and that it is in the test phase that both components come together for the last time before the market launch. Thereby the importance of the test phase during the development process of product-service solutions is emphasized.

Acknowledgements

This work has been partly funded by the European Commission through the FoF-ICT Project PSYMBIOSYS (No. 636804). The authors wish to acknowledge the Commission and all the project partners for their contribution.

References

[1] Spohrer J, Maglio P. Toward a Science of Service Systems. In: Kieliszewski, Maglio P, Spohrer J. Handbook of service science. Springer: New York; 2010, p. 157-194.
[2] Freitag M. Konfigurierbares Vorgehensmodell für die exportorientierte Entwicklung von technischen Dienstleistungen. Stuttgart: Fraunhofer Verlag; 2014.
[3] Spath D, Fähnrich KP, Freitag M, Meyer K. Service Engineering internationaler Dienstleistungen. Stuttgart: Fraunhofer Verlag; 2010.
[4] Cavalieri S. and Pezzotta G. Product–Service Systems Engineering: State of the art and research challenges. Computers in Industry 63.4 (2012): 278-288.
[5] Freitag M., Kremer D., Hirsch M., Zelm M. An Approach to Standardise a Service Life Cycle Management. In: Martin Zelm, Marten van Sinderen, Luis Ferraira Pires, Guy Doumeingts (Eds.). Enterprise Interoperability, John Wiley & Sons, Chichester, 2013, p 115-126.
[6] Freitag M, Hämmerle O. Smart Service Lifecycle Management. wt Werkstattstechnik online 2016; 106(7/8):477-82.
[7] Qu M, Yu S, Chen D, Chu J, Tian B. State-of-the-art of design, evaluation, and operation methodologies in product service systems. Computers in Industry. 2016 Apr 30;77:1-4.
[8] Pezzotta G, Pirola F, Pinto R, Akasaka F, Shimomura Y. A Service Engineering framework to design and assess an integrated product-service. Mechatronics. 2015 Oct 31;31:169-179.
[9] Tran T, Park JY. Development of a novel set of criteria to select methodology for designing product service systems. Journal of Computational Design and Engineering. 2015 Oct 22.
[10] Pezzotta G, Pinto R, Pirola F, Ouertani MZ. Balancing product-service provider's performance and customer's value: The service engineering methodology (SEEM). Procedia CIRP. 2014 Dec 31;16:50-5.
[11] Freitag M, Ganz W. InnoScore® service. Evaluating innovation for product-related services. In: Service Research & Innovation Institute (Eds): Annual SRII global conference (SRII) 2011, March 29, 2011 - April 2, 2011, San Jose, California, USA ; proceedings, IEEE, Piscataway, NJ, 214–221.
[12] Wiesner S, Freitag M, Westphal I, Thoben KD. Interactions between Service and Product Lifecycle Management. Procedia CIRP 2015; 30:36-41.
[13] Westphal I, Freitag M, Westphal I, Thoben KD. Visualization of interactions between product and service lifecycle management. IFIP Advances in Information and Communication Technology 2015; 460: 575-82.
[14] Burger T, Kim KJ, Meiren T. A Structured Test Approach for Service Concepts. International Journal of Service Science, Management, Engineering and Technology 2010; 30(4): 12-21.
[15] Sakao T. and Shimomura Y. Service Engineering: A Novel Engineering Discipline for Producers to Increase Value Combining Service and Product. Journal of Cleaner Production 2007; 15(6): 590-604.
[16] Ojasalo J and Ojasalo K. Using Service Logic Business Model Canvas in Lean Service Development. In: Gummesson E, Mele C, Polese F. (Eds.) Service Dominant Logic, Network and Systems Theory and Service Science: Integrating three Perspectives for a New Service Agenda. Naples: Conference Proceedings 5th Naples Forum on Service; 2016.
[17] Doumeingts G, et. al (Eds.). Deliverable 7.1 Product-Service Engineering – Conceptual Framework FIRST. PSYMBIOSYS; 2016.
[18] I-VLab (Eds.). Deliverable 7.5 Symbiotic Innovation in P-S Ecosystems FIRST.; 2016.