Development of an Interaction based Approach for Product Service System Implementation

An Approach towards PSS Usability

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Abstract: Product Service Systems (PSS) as a combination of product and service components offer an excellent opportunity to improve the competitive position of companies on the local and global market. The current PSS approaches in literature are especially adapted to large companies. In particular, the stakeholders of small and medium-sized enterprises (SMEs) block these approaches because of lack of usability. Because PSSs also provide many opportunities for SMEs to individualize their position on the market and to improve their relationships to their customers there is a need for a PSS framework adapted to the needs of SMEs. To provide this new concept of PSS to SMEs and also to follow the goals of usability this paper presents an interaction based approach considering aspects of current PSS frameworks. This approach of using Interaction Maps qualifies companies to apply all important steps for the implementation of a PSS. Therefore, all steps and interactions between important roles are documented and visualised in Interaction Maps. The interaction based approach takes all important stakeholders of the PSS process into account.

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1 INTRODUCTION

Produced assets such as a capital intensive special-purpose machine or a normal passenger car are seen more and more as commodities. Through globalization and the usage of new technologies it is nowadays possible to produce complex and engineering intensive products, which used to be the showcases of western industries, at a very low price and a remarkably similar quality anywhere in the world. Furthermore, today's speed of imitation and copying is enormous and is getting faster. Even the production quality is not a real argument for the buyer any more. Hence customers are unlikely to be attracted with classic arguments such as the quality or performance of investment goods. The service orientation of a product-oriented company seems to be a possible way out of the described dilemma, which a growing number of "traditional businesses" face these days. In order to cope with these changes and challenges, it is not enough just to expand the company's portfolio to some services. The adjustment to the concept of service orientation requires a transformation in the corporate culture, the leadership, the management and the company's internal processes right from the beginning. For this transformation companies are forced to put themselves into their customer's position and therefore become a part of the feedback cycle. Furthermore, the increasing integration into the customer's processes not only means a new field of action for traditional business, but also a tremendous opportunity to improve the development of new products. The experiences from the use of its products can be used to provide customers even more value out of the existing relationship, which in turn strengthens the relationship and thereby puts cost arguments of the global competition clearly into perspective.

The design and implementation of such a service approach through Product Service Systems (PSS), which consists by definition out of a service and a product component (Tischner, 2002), has already often been discussed in literature since the late 1990s (Baines and Lightford, 2013). However, this concept still lacks detailed understandable procedures for the introduction and the implementation of a Product Service System to an average small and medium-sized enterprise (SME) (Hernández Pardo et al., 2012). Practitioners look for pragmatic and applicable tools. Therefore, this

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research has the aim to determine the essential interactions for the preparation, development, introduction and the operation of such a system. Interactions are easy to understand for practitioners who are not familiar with academic approaches. Furthermore, a literature review in books, scientific magazines and on the web showed that currently there are no frameworks in this area which use interactions (see examples in table 1). Hereby a PSS framework is defined as a set of actions to build and implement a PSS in a company.

Table 1: Examples of current PSS approaches.

PSS-Approach	Description
Aurich et al. (2008)	Control loop model of life cycle management of capital intensive PSS: The authors designed a product life cycle for PSS from manufacturer and customer perspective from "organizational design" to "PSS Realization".
Lindahl et al. (2007)	Integrated Product and Service Engineering: Lindahl et al. created a development method with focus on environment-oriented business models and sustainable influence of consumption patterns with phases from "Need & requirement analysis" to "Take back".
Spath and Demuß (2003)	Model for hybrid product development: The model of the authors aims at the development of customized products and services. By means of a requirement model and requirement management the different engineering disciplines should coordinate their activities.

The current PSS approaches which could be found in literature are complex and quite academic methods. Therefore, they are especially suitable for large companies, which in general have a research and development department as well as the appropriate staff to work on these methods. In particular the stakeholders of SMEs block these approaches (Hsin and Ching-Fang, 2005). An average SME has a tight organisation, lean structures and practice-oriented staff. Their employees do not have time to become acquainted with these methods. The interaction based approach should take all stakeholders into account and facilitate the usage of current PSS frameworks. The approach is adapted to the structures of SMEs, i. e. kept simple and understandable. Therefore, it is especially applicable for SMEs.

Product Service Systems also offer a big opportunity for SMEs. To provide this new concept of PSS to SMEs and also to follow the goals of usability this paper presents a PSS framework translation tool, which includes all important steps to get to a PSS approach; therefore, all steps and interactions between all important roles are documented and visualised in Interaction Maps. For this paper usability is defined as: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." (DIN EN ISO 9241-1, 2002) Although the definition aims at products this focus could be extended to Product Service Systems.

The usage of an Interaction Map was necessary, because the process to implement a PSS is full of interaction and communication but low in actions on a higher level. In a deeper level of the framework a process modelling language, e. g. BPMN 2.0, can be used to document business processes on a lower level.

Having formulated the aim and benefit of the interaction based approach, chapter 2 outlines the foundations of Product Service Systems. Chapter 3 elaborates how the approach was developed and provides the main aspects of the approach. The paper concludes with a summary and an outlook in chapter 4.

2 PRODUCT SERVICE SYSTEMS

By laying the research focus on interactions and usability in this paper, the main emphasis was not on developing new Product Service System frameworks yet. However, comprehensive literature research on the subject was conducted and numerous publications about currently discussed taxonomies, PSS design frameworks and past as well as current research projects on this topic were accessed.

To give the reader an overview over the PSS subject, two definitions and one common classification of PSSs will be briefly introduced in the following chapter. Afterwards the "Product-Service-System Life Cycle" (Aurich and Clement, 2010), which is an interesting and well thought-out PSS framework, will be presented.

2.1 Definitions

To provide an understanding of the Product Service System topic two common PSS definitions are listed below:

"A PSS consists of tangible products and intangible services, designed and combined so that

they are jointly capable of fulfilling specific customer needs. Additionally, PSS tries to reach the goals of sustainable development." (Brandstotter et al., 2003)

"Product Service-Systems (PSS) may be defined as a solution offered for sale that involves both a product and a service element, to deliver the required functionality." (Wong, 2004)

Those two definitions show as others, too, that a PSS must always consist of a product and a service component. In addition to this, many common definitions also focus on a certain customer need or a certain utility which must be delivered by the system. Numerous, mainly European, definitions also include a focus on sustainability as a key part of PSSs. In this paper the definition of (Wong, 2004) is used.

2.2 Eight Types of Product Service Systems

The Dutch researcher Arnold Tukker classified Product Service Systems into eight types which are distributed from product-oriented over use-oriented towards completely result-oriented offerings. The insights which led to the development of his taxonomy are based on the results of an European Union founded research project named SusProNet (Sustainable Product Development Network) (Tukker and Tischner, 2006).

The following figure shows the three main and eight subcategories of a PSS according to Tukker (2004) and the following sections describe the graph in detail.

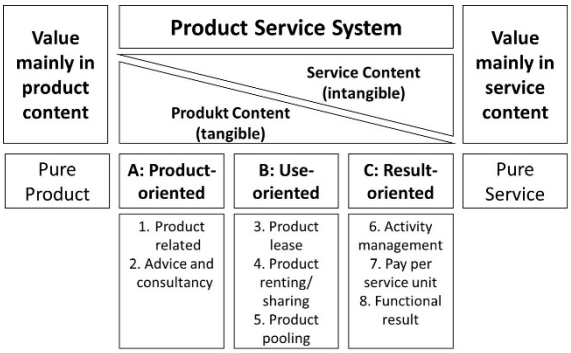

Figure 1: Main and subcategories of PSS (Tukker, 2004).

A Product Service System is always in between a pure product and a pure service. The PSS has a material product part and an immaterial service part.

Depending on the composition of the shares, the PSS can have three main categories: it can be product-, use- or result-oriented. (Tukker, 2004).

As a product-oriented PSS, it has a high proportion of product and can either (1) contain a product-related service component or (2) have a product-related consulting. Here both types offer added value for the customer by for example causing a more efficient use of material and human resources. (Tukker, 2004)

(3) Product Leasing has tangible value for the customer, since operating costs and maintenance are offered and performed by the provider. The provider usually has to take precautions, as a more careless usage by the customer can be expected due to the fact that the customer does not own the product. (Tukker, 2004)

(4) Product rental and product sharing demands a general deprivation of property from customers and therefore only the use of the product by direct need. Hereby the customer has to invest time and efforts in order to be able to use the product whenever it is needed. (Tukker, 2004)

For (5) product pooling the description is almost the same as for renting and sharing. The main difference lies in the user group which usually belongs to a certain circle of persons within an organization or a community. (Tukker, 2004)

(6) Activity management transfers staff and material costs from the user to the provider, which can generate profits through specific expertise and the efficient reorganization of the outsourced activity. (Tukker, 2004)

The concept of (7) payment per service unit of one or more activities provides a perceivable value for the customer. The position of the provider is located in the customer's value chain and is better for the provider in terms of direct customer contact, customer processes and customer loyalty. (Tukker, 2004)

The (8) functional result provides the same outcome as an activity which is carried out by the customer and thus brings the same benefit. In principle, the provider can try to offer a solution that requires a comparatively lower input. (Tukker, 2004)

2.3 Product Service System Life Cycle

As a framework which the research can be based on, the Product Service System Life Cycle approach of Aurich and Clement (2010) was chosen. The PSS Life Cycle describes how to plan and build up a Product Service System for capital intensive products.

Aurich and Clement's (2010) framework was analysed to afterwards apply the Interaction Map tool to the five life cycle phases described. Those are Organizational Design, PSS Planning, PSS Development, PSS Configuration and PSS Realization. Since this framework is a cycle, it starts with PSS Planning and ends with PSS Realization. The step of Organizational Design has to be conducted once for every use case. The following figure shows the PSS Life Cycle:

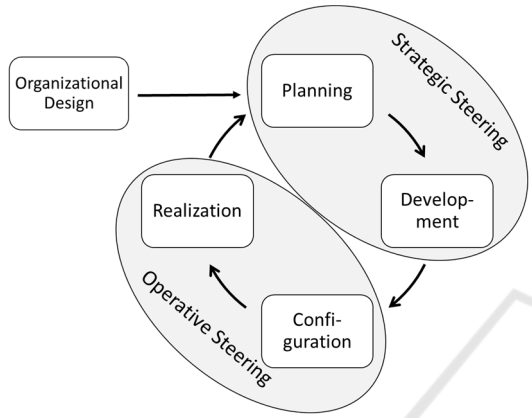

Figure 2: PSS Life Cycle (Aurich and Clement, 2010).

2.3.1 Organizational Design

The application of Product Service Systems provides traditionally oriented companies with special organizational but also corporate cultural challenges. In order to put the company on the path of development of a PSS, a one-time implementation of an organizational design is necessary. This normally begins with the decision of the management of wanting to introduce a PSS. At this time, there is no existing PSS expertise within the company. The knowledge must be acquired from outside. This can be done by means of tendering, headhunters or business consultants. It is of advantage to be able to attract an expert who not only has PSS expertise, but also leadership skills for the implementation of such a project. In the next step the business processes must be considered, and business models must be developed so that the PSS can be aligned to them. To ensure the acceptance of employees for the coming changes, they must be extensively trained and convinced of the benefits of PSS. Organizational and operational structure changes can be made with the acceptance of the employees. This is done using a proposed resolution, which will be presented to the board. It is also important to ensure that all levels of management share the new decisions. If some people are still not on board, they must be trained and instructed again. After that the implementation of the organizational design phase can begin on the team level. (Aurich and Clement, 2010).

2.3.2 PSS Planning

PSS Planning has the aim to define all planning related activities. Those include tasks like the definition of the product and its utility and the definition of the project goals. This phase is finalized with the PSS development assignment and the formulation of a PSS development request. The PSS planning phase gives companies the opportunity to generate and to rate PSS development projects. (Aurich and Clement, 2010).

2.3.3 PSS Development Project

The development phase has the aim to develop a market-ready Product Service System. By building on the preliminary work of the planning phase, the development process starts here. An important requirement is the systematization of the integrated product and service development. At the end of this phase, a PSS consisting out of products and services is developed. The last steps of PSS development are the creation of market specific offers, documentation and other formal procedures. (Aurich and Clement, 2010).

2.3.4 PSS Configuration

PSS Configuration aims to offer a customer individual Product Service System which also meets the provider's objectives. Therefore, the technical configuration of the physical product, the configuration of suitable and individual customer centric service products, the generation of different offer combinations and their evaluation and selection are necessary. The configuration phase is essential, because in order to exploit the strengths of Product Service Systems a custom-fit configuration is crucial. (Aurich and Clement, 2010).

2.3.5 PSS Realization

Besides from providing the configured PSS and generating customer utility, a core responsibility of PSS realization is the retention of a high quality offer and the ensuring of high-quality standards throughout the whole PSS Life Cycle. To be able to guarantee this, a continuous improvement process, performance measurement indicators and further improvement and monitoring measures are used. (Aurich and Clement, 2010).

2.4 Importance of Usability for a Theoretical Framework

The common PSS design frameworks are well reasoned, but quite academic and also often not user centred. Within the context of the research project "Use-PSS" many interactions with German SMEs showed that the companies are interested in new approaches but have great difficulties to cope with academic research approaches. These insights could be acquired during workshops with SMEs and discussions with participants of public presentations. This means, that the real life usability and applicability of these approaches often lacks a detailed description and guidance for SMEs. This paper's research has the aim to combine the existing academic frameworks with a tool, that helps to translate the academic research into real life action and interaction plans for SMEs which cannot afford a R&D department which brings complex research results to life.

3 INTERACTION BASED APPROACH FOR PSS IMPLEMENTATION

Based on Aurich and Clement's (2010) Product Service System Life Cycle framework, this chapter will introduce an approach to higher PSS-Framework-Usability. The following concept can be applied to many other frameworks to provide a better understanding of the detailed interactions required for an implementation of a PSS development framework.

The following figure 3 shows the integration of the interaction based approach in-between a PSS framework and the detailed business processes of a company.

The interaction based approach has the aim to help translate the often quite abstract and roughly described frameworks into a detailed business process model. Therefore, the interaction based approach is divided into two steps. In the first step several interaction matrices for each PSS Life Cycle phase are created. They contain the main process steps and the required information about interactions within these steps. In the second step of the interaction concept the matrices are separated into various Interaction Maps. Those are created for each process step within the interaction matrix.

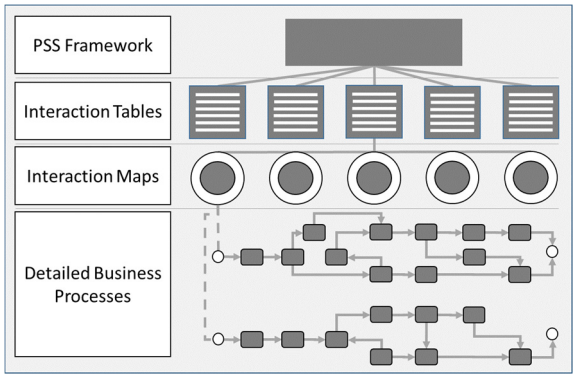

Figure 3: Integration of the interaction based approach in-between a PSS framework and a company's detailed business processes.

3.1 Interaction Description

This part focuses on the interactions within the company and also in-between the company and the external partners involved. Interactions concentrate on the existing roles within a company and their actions and communication within the Product Service System Lifecycle. Therefore, the term "interaction" is defined for the research as follows: Interactions are based on two or more-directional relationships between two or more actors, which can get in contact through synchronous or asynchronous communication. All processes of a company are affected by interactions.

To define a scope for the approach and to contain it, first the procedure of describing the interactions is elaborated. Furthermore, the single roles within a company are defined. Due to the fact that this is still a theoretical approach, it must be mentioned, that those roles do not fit to every firm.

The subject of interaction description for PSS is new and could not been found in the literature review, which was conducted prior to the development of this concept. Therefore, the development of the approach started from draft. The PSS Life Cycle framework (Aurich and Clement, 2010) which was introduced in chapter two provided a solid base for the interaction concept.

Figure 4 shows the transformation of the PSS Life Cycle framework down to a single Interaction Map.

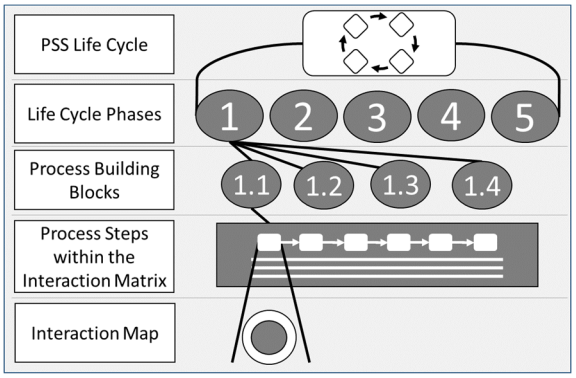

Figure 4: Transformation from PSS Life Cycle framework to a single Interaction Map.

In a first step the framework was split into the five Life Cycle phases (e. g. Planning) which were divided into many process building blocks (e. g. Planning Preparation). Afterwards each building block was converted into an Interaction Matrix. Each Interaction Matrix consists out of several process steps (e. g. Define Physical Product Core) which were separately analysed for their occurring interaction. Finally, an Interaction Map for each process step was created.

3.2 Interaction Matrix

The Interaction Matrix analyses each of the process building blocks and divides them into single process steps. A Matrix contains the process steps on the x-axis and the actors on the y-axis. Within the matrix, methods which can be applied to the steps as well as internal and external actors and their interaction status are shown. The status is visualized using the assigned symbols. Additionally, there is a possibility to add a short description to each process step at the bottom of the table.

During the interaction analysis phase the following interaction states can be assigned:

- **Active Actor; Symbol: +**
  The actor is actively involved in this phase and indispensable. He/she interacts with other participants. An active actor is always located in the inner circle of the Interaction Map.
- **Passive Actor; Symbol: -**
  This actor is not directly involved in an interaction but has a supporting function. He/she can have an indirect interest in a certain process part or may have an interest in getting certain information. This actor only delivers information for the main interaction process by request.
- **Doesn´t play a role**; **Symbol: 0**
  This actor doesn´t have any activity in this phase and is also not indirectly involved.
- **Role is non-existent at this time; Symbol: /**
  The actor in this phase is irrelevant and doesn´t have any reference concerning the presented interaction or process part.

Figure 5 shows an extract from the "Planning Preparation" Interaction Matrix.

Planning Preparation

Process	Define Physical Product Core (Basic Value)	Specify Manufacturer
Method	Workshop	Balanced Score
Actors		
Internal		
CEO	0	+
R&D	+	+
Manufacturing	0	+
Marketing	+	+
Sales	+	+
Procurement	-	+
Controlling	-	+
Service	0	+
HR	-	-
Logistics	-	-
PSS-Specialist	+	+
PSS-Team	/	/
External		
Cusomer	/	/
Supplier	/	/
Subsidiary	/	/
Dealer	/	/
Indep.Serv.Partner	/	/
Description	The Definition of a physical product stands at the beginning of the planning	Manufacturer goals (interna example to the realizable re

Figure 5: Extract from Interaction Matrix "Planning Preparation".

3.3 Interaction Map

The next step after creating the Interaction Matrix was a detailed analysis of the single process steps and their contained interactions. The main aim of the Interaction Map, which was inspired by Stickdorn and Schneider's (2011) "Stakeholder Map", is to give the PSS framework user a tool which allows the presentation and explanation of an implementation process in easy to understand interactions. The Interaction Map does not aim to replace established process modelling languages, it rather gives the practitioners a tool, which helps to translate a rough framework through interactions into detailed business processes. At this point of research, it is recommended using the maps with a short explanatory text of a few sentences.

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For the purpose of keeping the interactions within the Interaction Map simple and informative, the number of symbols used is limited. The following figure shows the symbols which can be used for modelling an interaction map.

Table 2: Description of the Interaction Map Symbols.

Symbol	Description
R&D	Organizational Unit / Role
	Synchronous Communication
	Asynchronous Communication
	Interaction Activity
	Message Flow
	Assignment
XOR	Connector exclusive OR
OR	Connector inclusive OR
AND	Connector AND

The following section explains the components and symbols of the Interaction Map in detail.

- The inner circle of the Interaction Map contains the active actors, which are involved in this phase and are responsible for the interactions.
- The outer circle contains all actors which are not directly involved in the interaction (Passive Actor) but can provide information for the inner circle or get information from the inner circle.
- Actors are the internal and external organizational units and roles of a company, e. g. CEO, marketing or supplier.
- The synchronous communication symbol stands for e. g. telephone call, video conference, live meeting or chat.
- The asynchronous communication symbol represents e. g. letter, telefax, email, internal social media or automatic communication via database.
- The activity symbol stands for the interaction between several actors. An interaction activity is always a synchronous communication and could be for example a meeting or a workshop.
- Data or information can be transferred via message flow. It is used for example to communicate the output of a meeting to actors in the inner or outer circle.
- An assignment shows the connection between an organizational unit or role and the interaction activity.
- In an Interaction Map three different connectors could be used. The AND signals that several interactions could be executed in parallel. The fact that only one out of several interactions could be executed is shown by the exclusive OR. The inclusive OR represents the fact that one or more interactions could be executed.

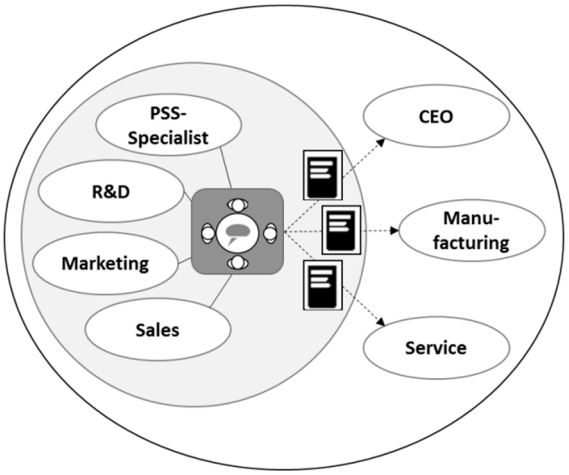

Figure 6: Interaction Map for the process step "Define Physical Product Core".

Figure 6 shows the Interaction Map of the first process step “Define Physical Product Core” of the “Planning Preparation” Interaction Matrix. It represents a workshop for defining the physical product core of a PSS. The organizational units R&D, Marketing and Sales as well as the PSS-Specialist are active actors in this process step. The output of the workshop is asynchronously reported to passive actors, CEO, Manufacturing and Service.

4 SUMMARY AND OUTLOOK

In this paper the importance of Product Service Systems as a combination of product and service components for companies to reach a better competitive position on the market was pointed out. The result of a literature review demonstrated that there are some PSS frameworks but they are not suitable for SMEs. Therefore, one of the aims of this paper is to provide an approach to implement PSS in a company which is suitable for SMEs.

Afterwards the new concept of PSS considering the requirements of SMEs was introduced. Therefore, an interaction based approach using Interaction Maps which qualifies companies to apply all important steps for the implementation of a PSS was presented. An Interaction Map documents and visualises all steps and interactions between important roles.

The interaction based approach was already reviewed in an expert discussion of several hours. Moreover, it will be evaluated through workshops with employees of selected SMEs. Further on a complete PSS framework will be developed in the research project "Use-PSS" for the implementation of PSS in SMEs. Therefore, the interaction based approach will be used as one methodology to document the communication and interaction of important roles and stakeholders in the implementation process. Furthermore, this PSS framework will be evaluated for SMEs while using some selected SMEs to develop and implement a concrete PSS idea.

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REFERENCES

Aurich, J. C., Clement, M. H., 2010. *Produkt-Service Systeme*, Springer. Berlin Heidelberg.

Aurich, J. C., Schweitzer, E.; Mannweiler, C., 2008. Integrated Design of Industrial Product-Service Systems. In Mitsuishi, M., Ueda, K., Kimura, F. (Eds.). *Manufacturing Systems and Technologies for the New Frontier*, Springer. London, pp 543-546.

Baines, T., Lightford, H., 2013. *Made to Serve*: *How Manufacturers can compete through Servitization and Product Service Systems*, John Wiley & Sons. Chistchester.

Brandstotter, M., Haberl, M., Knoth, R., Kopacek, B., Kopacek, P., 2003. IT on Demand – Towards an Environmental Conscious Service System for Vienna (AT). In *Proceedings of EcoDesign'03, 3rd International Symposium on Environmentally Conscious Design and Inverse Manufacturing*. IEEE, pp 799–802.

DIN EN ISO 9241-1, 2002-02-00: *Ergonomische Anforderungen für Bürotätigkeiten mit Bildschirmgeräten - Teil 1: Allgemeine Einführung* (ISO 9241-1:1997).

Hernández Pardo, R. J., Bhamra, T., Bhamra, R., 2012. Sustainable Product Service Systems in Small and Medium Enterprises (SMEs): Opportunities in the Leather Manufacturing Industry. In *Sustainability*, 4, pp. 175-192.

Hsin, C., Ching-Fang, W., 2005. A Comparative Analysis between SMEs and Large Companies in Relation to Integration Technologies Adoption. In *Proceedings of ICEB'05, 5th International Conference on Electronic Business*. Hong Kong, December 5-9, 2005, pp 839 - 848.

Lindahl, M., Sundin, E., Sakao, T., Shimomura, Y., 2007. Integrated Product and Service Engineering Versus Design for Environment – a Comparison and Evaluation of Advantages and Disadvantages. In Takata, S., Umeda, Y. (Eds.). *Advances in life cycle engineering for sustainable manufacturing businesses*, Springer. London, pp 137–142.

Spath, D., Demuß, L., 2003. Entwicklung hybrider Produkte – Gestaltung materieller und immaterieller Leistungsbündel. In Bullinger, H.-J., Scheer. A.-W. (Eds.). *Service Engineering – Entwicklung und Gestaltung innovativer Dienstleistungen,* Springer. Berlin, pp 463–502.

Stickdorn, M., Schneider, J., 2011. *This is Service Design Thinking*. BIS Publishers. Amsterdam.

Tischner, U., Verkuijl, M., Tukker, A., 2002. *First Draft PSS Review. SusProNet Report, draft 15 December*. Econcept. Cologne.

Tukker, A., 2004. Eight types of product-service System: Eight ways to sustainability? Experiences from SusProNet. In *Business Strategy and Environment,* 13, pp 246-260.

Tukker, A., Tischner, U., 2006. *New Business for Old Europe*. Greenleaf Publishing. Sheffield.

Wong, M., 2004. *Implementation of Innovative Product-Service Systems in the Consumer Goods Industry*. PhD Thesis, Cambridge University.

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