

PROPERTY RIGHTS THEORY AS A KEY ASPECT IN PRODUCT SERVICE ENGINEERING

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ABSTRACT

Product service systems (PSS) are a field of research which is supported by research in a large number of other areas. Product development and engineering design is the basis for most research projects but economic theory has a major influence too. The origin of the theory of property rights is the new institutional economy. Different types of rights concerning a property are described systematically and can be distributed separately. Although the distribution of property rights in general is a key aspect for the PSS design, the economic theory of property rights has not yet been introduced into PSS considerations in a broad and systematic way.

The aim of this paper is to close the gap and give a structured overview of the property rights theory and its potentials for PSS design. According to the procedure of the German VDI 2221 it is demonstrated how property rights considerations can support the different phases of a development process. Furthermore, it is demonstrated how property rights theory can support different goals in developing PSS and the authors present suggestions for a more differentiated look at the property rights distribution to improve the correlation with the requirements of PSS considerations.

Keywords: Product service systems, PSS, PSS development, property rights

1 INTRODUCTION

Not everybody is familiar with the research topic of product services systems (PSS) nowadays but the so called PSS are all around us. Concepts like renting and leasing of products are well known and widespread on the markets. In 1976 Obenberger and Brown promoted leasing and renting as a "consumption alternative in marketing" [1]. They suggested a change from the focus on ownership a focus on what they called *usership*, defined as "a broad term encompassing all types of consumption in which the consumer does not possess legal title of the product" [1]. This usership concept implies a rejection of the classic transfer of the legal title and a turn to renting and leasing concepts. The usership concept was not associated with the specific considerations of the economic property rights theory at that time.

The goals in PSS research range from a strong focus on ecological aspects, e.g. Mont [2] and Roy[3] to a focus on economic aspects, where most researchers consider a B2B context, e.g. Fuchs [4] and Schweitzer [5].

The original concept of PSS is relatively young and several authors set different focuses. The definition of Goedkoop et al., who define PSS as "a marketable set of products and services capable of jointly fulfilling a user's need" points out the quintessence of the PSS considerations [6].

Independent from the reason for developing something as a PSS – the difference to a classic product often is connected with the differentiated distribution of property rights concerning the product.

In the context of the New Institutional Economy, the theory of property rights provides a distinguished overview of rights and resulting duties towards a commodity that can be distributed in different combinations. This theory and the differentiation of rights will be explained later in section 3.

A brief overview of current PSS development approaches, problems of PSS development in general and the introduction to property rights theory is given in section 3 and the opportunities for PSS development are displayed. Thereafter the application of property rights theory along the different phases of the product development process is presented. Although the VDI 2221 is used to show the appropriateness of the concept in the development process, the presented approaches are applicable for other methods of product development and can support specific methods for PSS development too. Moreover, the consideration of property rights is the key to a change from product oriented development to result orientation, which sets focus on the customer needs.

2 CURRENT PROBLEMS AND STATE OF THE ART IN PSS-DESIGN

What appears at the market as some kind of PSS is often designed with traditional product development methods like VDI 2221 and not with specific methods that consider product and service as equally prioritized components in a system.

Today there is a number of approaches to support a systematic integrated PSS design (e.g. Botta 2007 [7] or Abdalla 2006 [8]). But the suggested approaches are quite special and base on a specific view on PSS. None of the approaches has yet become some kind of standard. And although property rights theory is a core theory of new institutional economy, none of the approaches has considered it so far.

The consideration of property rights theory as a support for PSS development has only been published in two cases, until now: Hockerts suggested to change the focus on the service part of the PSS to a consideration of property rights distribution to enhance the eco-efficiency of PSS but without further advice for the integration of this findings in the development process [9]. Dill and Schendel refer to the property rights theory as a support for a systematic design of variants in the PSS development, but again without explicit advice how this could be integrated into existing PSS considerations [10]. Thus, the following description of types of property rights will be focusing on PSS considerations. Development process oriented examples of utilization of the theory are given thereafter.

3 PROPERTY RIGHTS AND THEIR SUPPORT FOR PSS DESIGN

3.1 The theory of property rights

The theory of property rights is one of the core theories of the new institutional economy – a rising subject of economic research since the 1970s. Next to property rights theory, the new institutional economy covers other important economic theories, e.g. the principal agent theory, the theory of transaction costs, assumptions of bounded rationality and asymmetric information [11]. The old picture of the *Homo oeconomicus* who acts rational appropriate to his preferences and aims for maximizing his utility is turned into a more realistic picture of human behavior and the situation in the economy. This implies consideration of opportunistic behavior and other characteristics that are in opposition to the old picture.

The following description of the types of property rights is based on Hockerts [9] and Furubotn/Pejovich [12]. It is important to point out, that the first three property rights include obligations which need to be considered for PSS design too. These obligations can lead to opportunities for the PSS design as well as the rights do.

1. The right to retain profits
(The duty to cover losses)
2. The right to maintain and operate a product
(The obligation to maintain a product)
3. The right to dispose of a product
(the duty to pay for the disposal of a product)
4. The right to exclude others
5. The right to use a product

Additionally Furubotn and Pejovich add the concept of attenuation, which explains the existence of some degree of restriction an owner can have [12]. These restrictions can concern:

1. Changes in form, place of substance of an asset.
2. The transfer of all rights to an asset to others at a mutually agreed upon price.

Such restrictions are traced back to the general legislation that can restrict the rights of an individual. In the first case it could be restricted by law. For example what types of buildings are allowed in a building area? What kinds of changes are allowed to be carried out when it comes to a landmarked house?

In the second case the reason could be fixed prices for special commodities in a market, e.g. drugs that are only available on prescription in a county.

This concept of attenuation can be extended for the consideration of property rights in PSS development by integrating the legal situation for the subject matter. Depending on what the PSS is

supposed to contain, it could be restricted by different laws and provisions. This could be e.g. restrictions on chemicals or safety restrictions, as well as general environmental legislation.

3.2 Extended differentiation of property rights

The authors suggest a more detailed extension of the presented differentiation of property rights. To meet the requirements of PSS concepts and PSS development a separation of the rights to maintain and operate the product is suggested. In various PSS we have today, the service part offered by the provider is to maintain, while the customer operates the product/system.

Therefore the authors suggest the following:

2a: The right to maintain the product (Covering the obligation to maintain the product)

2b: The right to operate the product

It is important to point out, that this property right distribution only describes who is in charge of the process “maintenance” and therefore taking care of the product and fixing it if needed. The responsibility for the costs of the maintenance is not connected to the property right, but has to be defined in the legal contract of the PSS. These circumstances can be used in PSS design to handle problems of opportunistic behavior. E.g. in a car sharing scenario the provider is in charge for the maintenance. For the costs for repairing damages caused by accidents the users who were responsible are charged.

3.3 Potential of property rights in PSS design

The theory of property rights distribution can be applied to achieve different goals in PSS development. One of the popular goals of PSS is eco-efficiency. In 2008 Hockerts presented „property rights as a predictor for the eco-efficiency of product-service systems“[9]. He suggests turning the focus from a service centered development approach to a focus on property rights distribution. By explicit choice of the property rights constellation it is possible to directly focus on eco-efficiency topics such as material intensity or reduction of energy consumption. Moreover it is pointed out that problems like opportunistic behavior or asymmetric information can reduce the eco-efficiency of PSS, but can be solved or alleviated by selective property right distribution.

As a general approach for PSS design Dill and Schendel suggested to regard property rights distribution as an opportunity to conduct a systematic variation in PSS design with a well known pattern of variation.

These approaches are picked up again in section 4.1.

To set the property rights considerations into a well know product service systems context, the will be used to describe the eight types of product service systems by Tukker as they are presented in Figure 1.

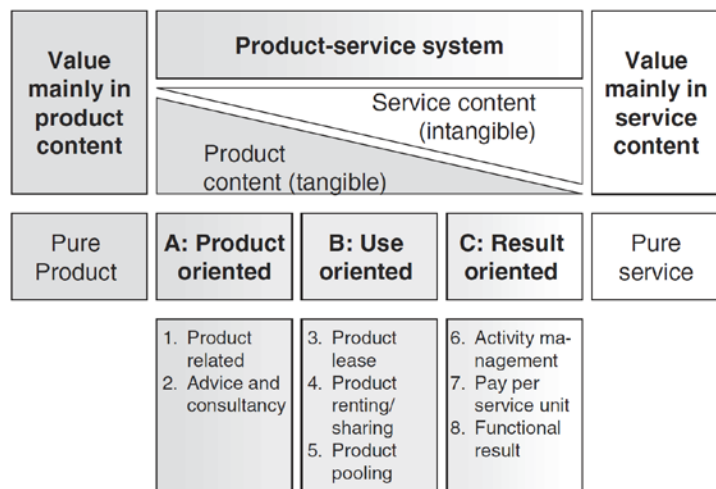


Figure 1. Types of PSS according to Tukker [15]

The following Table 1 provides an overview of correlations between the presented eight types of PSS according to Tukker in Figure1.

Table 1. Correlation of PSS type according to Tukker and property rights distribution

Type of PSS according to Tukker	Property rights distributed to provider	Property rights distributed to customer
1. Product related	- Depending on the product related service, the provider get's the required rights to carry out the service	- In general all rights are distributed to the customer - Exceptions depend on the required rights to carry out the product related service
2. Advice and consultancy	- Usually no rights are distributed to the provider	- All rights are distributed to the customer
3. Product lease	- for a defined time span the provider gives all rights beside the right to dispose to the customer until the product is given back or the product is finally sold to the customer	- The right to exclude others
4. Product renting/sharing	- A right/duty to care for the maintenances	- The right to use the product - The right to exclude others while using
5. Product pooling	- A right/duty to care for the maintenances	- The right to use the product
6. Activity management	- Depending on the type of activity management	Depending on the type of activity management
7. Pay per service unit	- The provider holds all property rights but can't really use the right to exclude others	The rights to use
8. Functional result	All rights are distributed to the provider	No property rights on customer side

The distribution of the rights can be altering, depending on the point in time that is considered. The differences between various types of PSS are only visible if a longer period of time is regarded. This point will be explained with an example of car ownership, leasing and renting in the following:

By the time the driver is on her way in the car, driving from A to B all three variants look quite the same. At the End of the journey, the rented car will be returned to the car rental station, but the other cars stay with their driver.

When it comes to inspecting the car, the leased one usually is taken to the garage and paid for by the lessee, as well as in the case of owning the car. In contrast to this, the vehicle of a car rental service is taken there and paid for by the provider.

Figure 2 illustrates the difference between product lease and product sharing with an example of cars.

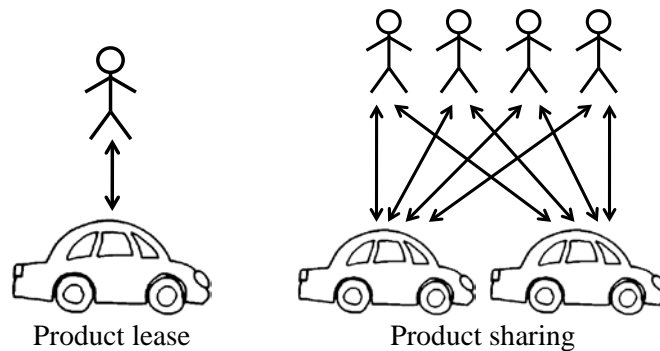


Figure 2. Examples of Types of PSS according to Tukker [15]

4 INTRODUCTION OF PROPERTY RIGHTS INTO SYSTEMATIC PSS DESIGN

4.1 Property rights in different phases of PSS design

In product development the German Guideline *VDI 2221 - Systematic approach to the development and design of technical systems and products* is well known in science and industry. It is known to be useful for developing material products as well as software [13].

The following Figure 3 shows the procedure of VDI 2221 with different phases of the development process. The phases of the development procedure are used to present different approaches to support the development via property right consideration.

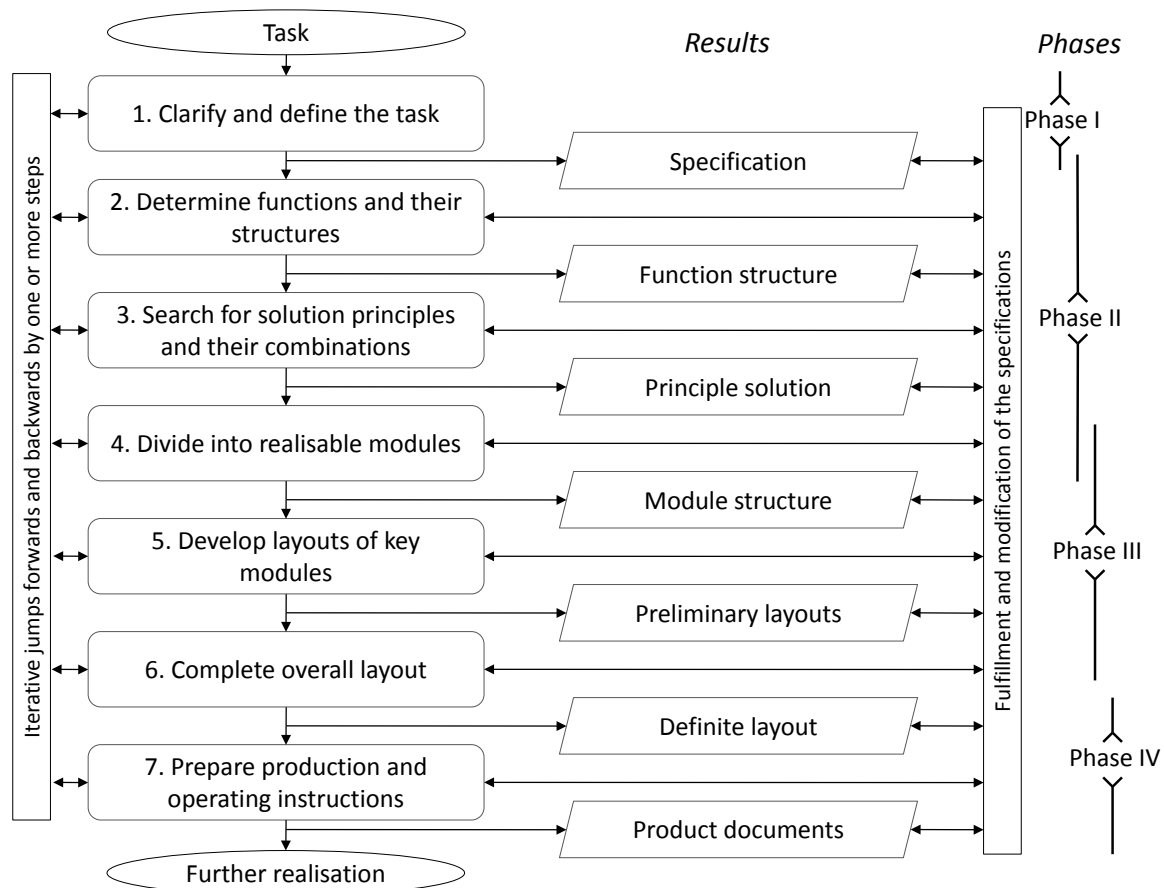


Figure 3. product development process according to VDI 2221 [13]

4.1.1 Phase I

For the clarification and definition of the task and the specification it is important to agree on the meaning of words and descriptions that are used. The usage of the property rights theory as a clarified concept of rights distribution can prevent misunderstandings and describes specific correlations with clear words.

Furthermore the consideration of property rights in the first phase provides inspiration for the participants in the process of clarifying and defining the task. This supports the turn from pure ownership thinking towards a more detailed look at different types of PSS and their feasibility to the task of development.

Additionally the consideration of property rights distribution can enhance the development process to reach a goal like "low material intensity" by specific choice of corresponding rights.

4.1.2 Phase II

For the second phase property rights distribution might have already been determined in the first phase. From this predetermined constellation further requirements can be derived and more detailed specifications of the property rights distribution can be established.

In the process of designing solution variants, property rights theory can be used to apply systematic variation in general, as well as to create special variants to reach a specific goal like eco-efficiency.

4.1.3 Phase III

For the steps in the third phase the property rights theory can be used to identify gaps in the solutions. A systematic survey of the different rights can assure that all aspects of the PSS are covered.

4.1.4 Phase IV

In the last phase a definite layout is available, the product documents are written and preparations for production and further realisation take place. With the support of the differentiated property rights considerations it is possible to describe the chosen constellation in a systematic way, that is easy to follow for everyone who is familiar with the basics of property rights theory.

The preparation of the legal contract is supported too. The requirements for the content of the contract can be derived to some instance from the allocation of the property rights.

4.2 Property rights theory as guideline for checklists in PSS design

Checklists are a common method to support the product development process [14]. The usage of checklists enables developers, independent from their specific knowledge. These property rights focused checklists help to find the right questions to cover important points during the development process as well as to support the necessary decisions. The property rights theory provides a structured basis for checklists due to the different opportunities they provide. Therefore it is possible to state different questions for the allocation of the property rights to enhance an efficient development.

The following Table 2 provides a checklist example to support an appropriate property right distribution in PSS development:

Table 2. Example checklist "Questions for property right distribution"

Type of right/duty	Distributed to provider	Distributed to customer
The right to retain profits (The duty to cover losses)	Is it possible to calculate the potential profits/losses? Can the profits or losses be influenced by the customers' behavior? Can the provider raise his profits or lower the losses by his behavior?	Is it possible to calculate the potential profits/losses? Has the customer influences on the profits or losses?
The right to maintain and operate a product (The obligation to maintain a product)	Is there the right infrastructure to maintain and operate the provided product(s)? Is there a reliable cost calculation?	Is the customer able to maintain and operate the product? Are special tools or trainings needed to enable the customer to maintain and operate the product? Strengths and weaknesses in the areas of maintaining and operating the product compared with competitive products?
The right to dispose of a product (the duty to pay for the disposal of a product)	Is there a benefit for the provider? E.g. recycling of products parts of material needed?	Are there special requirements the customer has to take care of? Does the disposal cause extra costs/effort for the customers, which decrease the attractiveness of the PSS? Is there a law that prevents the distribution of the right to the customer?

The right to exclude others	Can the provider exclude others and still run the PSS? How can the others be excluded? Is there technical support?	If not given: take care of the parts that are responsible for personalizing the product for every new user if users change regularly How can the others be excluded? Is there technical support?
The right to use a product	Is it possible to only distribute this right to the provider? What bundle of rights is needed to be able to use the product?	Is it possible to only distribute this right to the user? What bundle of rights is needed to be able to use the product?

Checklists can also be used for the implementation of goals. In those types of checklists, certain allocations of the property right are proposed to achieve the desired effect, for example eco-efficiency.

5 DISCUSSION

Product service systems are a field of research that matches different research areas. Complex knowledge is necessary and existing procedures for PSS development have not yet been established as general standards. Methods and tools that support the development process of PSS – independent from the chosen design procedure – are required for further success and market penetration of the concept of PSS.

The presented theory of property rights is an established economic theory with a long tradition in research. It supports the view of different types of PSS in a structured way. Compared to earlier research like the eight types of PSS by Tukker [15], it is not a competing approach but more a complementation and extension of the concept.

The authors suggest dividing the existing consideration of “the right to maintain and operate the product” into separate rights to better meet the requirements of PSS design. Further changes to the traditional segmentation, towards a more PSS suitable segmentation of the rights, should be discussed and tested in development projects.

A weakness of the concept is the time aspect. In the classic segmentation it is not possible to distinguish e.g. a car sharing offer from a rented car without addition of information about the time span that is covered. Implementing a time aspect would support the usability for PSS design.

While talking about property rights distribution and usership arrangements it is important to point out that there are cases in which the core benefit is about having something somebody else can not have. Usually these needs are fulfilled by ownership arrangements, but even for such constellations it is possible to build usership arrangements regarding the adequate property rights distribution that fit.

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