

Implications of new institutional economy theory for PSS design

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Abstract

At the institute of product development a machine elements (pmd) of Technische Universität Darmstadt, Product Service Systems are researched as objects of design. In particular, the application of principles and methods of systematic engineering design to PSS design is examined. The aim is to contribute to effective PSS design by generating and evaluating design variants on different levels of concretization.

This paper focuses on, the interactions between customer and provider in a Business-to-Consumer scenario. An earlier idea of segmenting PSS into episodes of customer/provider interaction is expanded and an approach for applying selected methods of new institutional economics to the evaluation of design variants is presented.

Transaction cost and property rights distribution are proposed as evaluation criteria and suggestions for reducing the consequences of asymmetric information are given.

As an example, various alternatives for a PSS “laundry / cleaning clothes” are considered and the results are presented.

Keywords

PSS design, new institutional economy, variant design

1 INTRODUCTION

The roots of PSS research at pmd lie, as with other engineering institutes involved in the topic, in EcoDesign. Earlier work on the use phase of products has demonstrated that there is considerable influence of (sometimes erroneous) user behavior on the environmental performance of a product during use (e.g. [1]). Information on the actual future use processes of a product (as opposed to those envisioned in designing) is limited during the design process. Through the continued interaction between customer and service provider, the PSS concept offers better information on, and, depending on the particular type of PSS, control over these use processes. With the wider scope, a designer has the opportunity to purposefully redistribute responsibilities, risks, benefits, and costs in the system.

How this can be leveraged into enhanced customer value, opportunities for revenue for the provider, and a better environmental performance of the system compared to traditional manufacturing, sale, and use of products, is a subject of PSS design research.

2 RESEARCH BACKGROUND

Current research at pmd is focused on the question if and how concepts and procedures from product design may be adapted to benefit PSS design in achieving the aforementioned aims. It is assumed that some basic characteristics can be transferred: Design starts with an idea or a task to provide a particular benefit to a future customer. From then on, a solution space is explored and successively more concrete and detailed plans of the product are drawn up.

A particular trait of systematic engineering design is that it provides models of the object of design (the product) and of the process, which helps to segment the task into subtasks (cp. [2]). For these subtasks, solution variants can be found and evaluated: While it is often very hard to determine an absolute measure for the quality of a

solution concept, particularly in the early stages of design, relative measures of multiple variants can often be compared to give an indication of the merits of certain solution ideas.

In order to facilitate a similar mode of working in PSS design, a set of models on a relatively low level of formalization has been devised, mostly adapted from existing models from product and service design [3]. Following Bullinger et al.’s concept [4] of services, considering a resource, process, and result dimension, they represent PSS in a series of successively more detailed process models, each entailing a transformation of resources into results. At the core is the segmentation of the PSS into “episodes” delimited by the arising of a need on the part of one of the actors and its fulfillment. In its current form, the model system comprises:

- A textual overview, providing the basic outline of the system with boundary conditions and functional unit
- An episodes overview, in essence a swimlane diagram, representing the causal and temporal relations between the episodes in the system
- An episode process model, describing the basic transformations occurring in an episode and based on the process model of [5]
- Blueprints of the episodes under development (see Figure 1) – Blueprinting is a method introduced to service design by [6]. It is modified here to include, besides the activities of the participants, the product and resource functions as cues for product design.

The purpose of these models is to provide a frame of reference for formulating solution variants and evaluating them against each other. In this paper, the focus is on the evaluation and on the role that theory and concepts from new institutional economics can play in it.

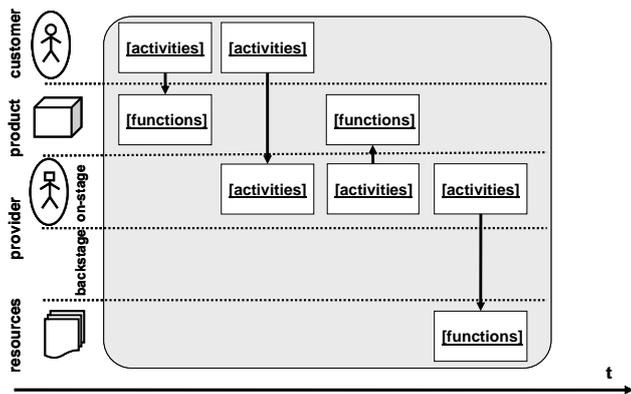


Figure 1: PSS blueprint schematic

3 APPROACH: NEW INSTITUTIONAL ECONOMY

New institutional economy is a sub-domain of economic research. It dismisses the assumptions of perfect rationality and utility maximization on the part of the economic actors. A more realistic view is provided instead, emphasizing problems concerning transactions and information. A number of theories developed in or attributed to the context of new institutional economy, are indispensable in modern economies. The well-known principal agent theory for example is essential for modern contract theory and therefore a basis in today's insurance business. The consideration of theories of new institutional economics to improve PSS is suggested by several authors (e.g. Scholl [7], Hockerts [8]).

In this paper, the focus is on determining the applicability of the theories of

- transaction costs
- and property rights

to the evaluation of PSS variants given in the models described above.

Furthermore, the influence of the assumptions of

- bounded rationality
- and asymmetric information

is investigated.

3.1 Transaction costs

At the center of the considerations of new institutional economy is the existence of transaction costs. [9] Transaction costs are a monetary representation of the effort involved in comparing or assessing different possible transactions [9].

New institutional economics know many types of transaction costs, like searching or information costs, costs for negotiation and decision making, as well as costs for supervising and monitoring. [9]

Due to these transaction costs, people usually settle for an acceptable solution to their needs, instead of the ideal solution (since the effort of seeking out the ideal solution would be excessive). With regard to PSS, the concept of transaction costs can help to elaborate benefits or drawbacks of different solution variants.

3.2 Property rights distribution

To improve the eco efficiency of PSS, Hockerts suggests a property rights centered approach and states "Why the Focus Should be on Property Rights Rather Than Services" [8]. He claims that PSS scholars stick to the service aspect, while trying to reduce the inefficiencies of PSS. The redistribution of property rights is proposed to induce efficient acting, as well on the producers as on the customer's side. Even if an occasion of opportunism

presents itself and is characterized by bounded rationality and information asymmetries, this mechanism works.

In literature the number of property rights being differentiated varies from four to five. This paper follows the five types as used by Hockerts [8]:

1. the right to retain profits
2. the right to maintain and operate a product
3. the right to dispose of a product
4. the right to exclude others
5. the right to use a product

Hockerts claims that the first three rights cover important obligations as well :

1. the duty to cover losses
2. the obligation to maintain a product
3. the duty to pay for the disposal of a product.

3.3 Bounded rationality

This assumption shifts the view on the economic actor from the 'homo economicus', who was characterised as always rational and maximizing his utility, to people who are expected to make decisions which seem to be irrational and not driven by economic calculations. These assumptions are the key to a better understanding of the dynamics of economic behaviour, in ways which are relevant to PSS. Example: lots of people own cars, even if strictly calculated in economic ways –considering transaction costs and opportunity costs – the participation in car sharing would be the best solution. This can be traced back to an overestimation of the lack of comfort and availability as well as the resulting costs, supplemented with an underestimation of the total cost of car ownership. Addressing these factors is important when designing PSS with supposedly rational economic and engineering methods.

3.4 Asymmetric information

Asymmetric information is the reason for a number of economic problems and reducing the effects of asymmetric information is one goal of economic theories and mechanisms. The traditional approach of finding an optimal solution is restricted by the differences in the availability of information about the object of the contract. Usually for products the manufacturer has better information about the quality of the product. This information asymmetry is even more crucial if the tangible product is replaced or supplemented by a service. The problems of perceived quality and the impossibility of an assessment of the services quality previous to participation or making use of the service is discussed in literature (e.g. [10]).

Overcoming the problems of asymmetric information is a challenge for PSS design. Different approaches are made in new institutional economy with methods like signalling and screening. For the purpose of this paper, however, the focus is on the effects of property rights distribution on reducing consequences of asymmetric information. Moreover, the problem of transaction costs due to the problem of asymmetric information is discussed.

4 EXAMPLE CASE: „WASHING CLOTHES “

"Cleaning dirty clothes" is used as an example here for several reasons:

- It is readily accessible to readers, since the vast majority of people is, at some point, faced with the necessity of getting their clothes cleaned
- The availability of data and general information on user behavior and market situation of the solutions is good

- Some of the solutions in the market constitute nicely integrated PSS (laundry, coin-operated laundromats)
- The example has been the subject of PSS research several times before [11], which allows for a comparison between the different suggested representations of the topic.

The presented cases are considered as PSS cases because they are developed as a combination of both, the product and the service, to satisfy the customer needs.

4.1 Scope of solution variants

In keeping with the aim of supporting a „top-down“ design process, three fundamentally different variants of systems for washing clothes are presented below. (In a real design process, decisions on the more general levels would have narrowed the solution space before blueprinting would start, but the examples here are selected to demonstrate the possible range of variants which can be compared.) The PSS variants are described later on in a short abstract and in the following sections in detail.

To get an outline on the actual ‘common situation’, which is used as reference case, there is a description of the usual condition. The market saturation in consumer washing machines being well over 90% in many European countries, “washing at home with a user-owned machine” is considered the reference case here.

The washing machine is normally sold with a warranty. However, since the service life of the machines is usually considerably longer than the warranty period, it is assumed here that the owner is in charge for the maintenance and has to pay for repairs if necessary. The decisions about the dosage of detergent and the choice of washing program are made by the user.

The first episode to consider here is plainly “washing clothes”. To compare the cases a **typical episode** is chosen: **cleaning laundry**. All related activities are enclosed in it; the need is for the clothes to be clean and the fulfilment is achieved when the clothes are taken out of the machine. This may seem trivial, but other solution variants may comprise more episodes with opportunities for designing in added customer values.

This episode, and later on others, is evaluated for 3 different PSS variants:

- **The reference case:**
This case consists of the situation described above with privately owned washing machines in private households. The customer is in charge of every action and decision.
- **Case ‘rented machine with full technical support’**
In this case the customer only rents the machine from the provider, who is still the owner. The customer uses the machine as if it was his one, but has the provider as regular maintenance service and in case of damage as repair service. If the machine is not working, the provider is obliged to repair the broken machine or to exchange it with a working one.
- **Case ‘laundry service’**
In this case the customer just hands his laundry in and every machine interaction and the whole cleaning process happens at the providers place.

The customers utility ‘getting clean cloth’ is gained in all of the different PSS. Therefore it is possible to compare the PSS, and especially the episode cleaning cloth.

4.2 The reference case

The reference case, which is characterized above, is now presented in a blueprint for evaluation. The blueprints can be interpreted as follows:

The blueprint as described above is a structured description of activities and functions. The blueprint enables the designer to point out the aspects that are important in the phase of development he is in and with the knowledge about the customer he has at that point. With the knowledge about transactions costs and property rights, the content of the blueprint can be evaluated as it is demonstrated in the following.

In the tables about transaction costs and property rights, there is a third column, called assessment (AM). This column indicates the effect on the overall assessment of the PSS utility. The background is the consideration of an average customer, that is able to wash on his own, but willing to pay for convenience as well.

The most remarkable aspects of transaction costs are marked with a TC and the ownership as type of property right is marked as well.

For the blueprint, the reader is referred to Figure 2 at the end of the paper.

The steps of the **reference case** look like this: Taking the laundry to the washing machine (WM), deciding about pre-treatment of staining, the amount and type of detergent and apply it; starting the WM.

Actor	Type of transaction costs	AM
customer	• Information costs for how to treat the laundry	-
provider	Is not participating in the PSS at that point, therefore no transaction costs	

Actor	Type of property right or duty	AM
customer	• The ownership of the machine assigns all rights and duties to the owner • This includes, that the owner is fully responsible if something goes wrong in the episode	+ -
provider	Is not participating in the PSS at that point, therefore no rights or duties	

Another episode, that is usually interesting to look at in PSS, is payment. For this standard case example there is the payment for the washing machine, when it is bought and a regular payment for resources (water, electricity). It is possible to design variations for the payment episode, but this case is supposed to be reduced to the regular situation in usual households.

4.3 Case ‘rented machine with full technical support’

The blueprint of the episode ‘washing’ looks exactly like in the standard case. While using the machine without technical problems no difference of an owned machine and a rented one is experienced. The Episodes with the obvious differences are the ‘technical problem’, ‘buying’ and ‘disposal’.

For this case the **payment episode** provides multiple options for variation. The payment can be instantly for each usage, or in a monthly pattern but usage bound. There could also be a fixed price model independent from the intensity of usage as well as a get money back model for not calling for the service in a year. As well as the amount and frequency, it is possible to vary the co-contractor. The machine could be provided from the same service provider who is partner for water and electricity and be a content of the contract.

Actor	Type of transaction costs	AM
customer	<ul style="list-style-type: none"> Information costs for how to treat the laundry (e.g. temperature, program, detergent and drying method). But due to the nature of repeating this episode regularly with the same or similar clothes, this costs are little determinant for the PSS decision. no transaction costs for booking the machine or alike come up, and the machine is free and ready to use whenever needed. 	- ++
provider	<ul style="list-style-type: none"> costs for assuring availability for problem reports costs for searching the damage/reason for damage 	- -

Actor	Type of property rights or duty	AM
customer	<ul style="list-style-type: none"> the right to exclude others the right to use the product The right to maintain and operate the product in terms of regular careful usage including cleaning 	+ + +
provider	<ul style="list-style-type: none"> The right to retain profits The right to maintain and operate the product in terms of technical maintenance 	+ +

4.4 Case 'laundry service'

For the blueprint, the reader is referred to Figure 3 at the end of the paper.

Actor	Type of transaction costs	AM
customer	<ul style="list-style-type: none"> costs for finding out when to bring the laundry and pick the laundry up costs for the transportation 	- --
provider	<ul style="list-style-type: none"> costs for the decision about how to treat the laundry - due to experience, they are supposed to be much smaller on the provider side, then on the customer side costs for arranging optimal utilisation of the washing machines to get all the laundry done in time 	+ -

Actor	Type of property rights or duty	AM
customer	<ul style="list-style-type: none"> no rights or duties concerning the washing machine at all. Just the right to get the machine used for his aim. 	+
provider	<ul style="list-style-type: none"> the provider is owner of the machine and owns all direct rights or duties 	++

For the case 'laundry service', the episode payment is a source for variation too. Payment can be per piece, per usage, per monthly or dependent on weight and dirt. The latter is an example for reducing transaction costs. If the payment is monthly by debit, the customer only needs to make sure that there is enough money or overdraft value to pay. In a 'pay each time you use' variation, that could be even worse by only accepting cash, the customer has

transaction costs for checking and securing his liquidity every time.

Conclusion of the case description:

All described PSS variants fulfil the same utility 'cleaning cloth' but with different levels of customer interaction

4.5 Trouble episode 'broken machine'

After the description of the episode 'cleaning laundry' a second episode is examined for the three types of PSS. To be able to compare PSS relating to their overall utility, it is important to consider the typical episodes of usage as well as episodes of anticipatory problems. Often there is a significant difference between the PSS types in these episodes.

Thus an episode of handling a broken machine, that doesn't work anymore, e.g. due to a broken part inside, is presented as well.

Broken machine in the 'regular owned machine' case

The customer will be the one who discovers that the machine does not work. Supposed that the warranty is already expired, the customer has to order a repair service of his choice. Usually this requires getting information about who is qualified, which prices need to be paid and if there is a service with good reputation. The customer must enable the repair service to reach the machine for repairing – on his own or by an authorised other person, and pay the bill afterwards.

Actor	Type of transaction costs	AM
customer	<ul style="list-style-type: none"> costs for gathering information about qualified repair service and deciding who to order costs for organising and supervising the repair service 	- +
provider	Is not participating in the PSS at that point, therefore has no rights or duties.	

Actor	Type of property rights or duty	AM
customer	<ul style="list-style-type: none"> All rights... ...and duties belong to the customer 	+ -
provider	Is not participating in the PSS at that point, therefore has no rights or duties.	

Broken machine in the case 'rented machine with full technical support'

Depending on the type of damage and the technical equipment, the damage can be detected by the customer or the electronic system of the machine. In the first situation, the customer calls the provider and makes an appointment for the repair service. In the second situation the customer is contacted by the provider.

Actor	Type of transaction costs	AM
customer	<ul style="list-style-type: none"> Little costs for finding out what is to be done 	++
provider	<ul style="list-style-type: none"> Costs for evaluating what damage needs to be repaired Costs for organising a backup machine 	- -

Actor	Type of property rights or duty	AM
customer	<ul style="list-style-type: none"> the right to exclude others the right to use the product The right to maintain and operate the product in terms of regular careful usage including cleaning 	++ ++ +
provider	<ul style="list-style-type: none"> The right to retain profits The right to maintain and operate the product in terms of technical maintenance 	+ +

Broken machine in the case 'laundry service'

If there is one of the laundry services' machines is broken, usually the customer does not even know if something alike happens.

Actor	Type of transaction costs	AM
customer	No cost due to the "broken machine"	++
provider	<ul style="list-style-type: none"> costs for arranging repairing costs for arranging a new utilisation of the washing machines to get all the laundry done in time 	- -

Actor	Type of property rights or duty	AM
customer	<ul style="list-style-type: none"> no rights or duties concerning the washing machine at all. Just the right to get the machine used for his aim. 	+
provider	<ul style="list-style-type: none"> the provider is owner of the machine and owns all direct rights or duties, therefore especially the duty to for maintenance in this case 	+

5 EVALUATION OF VARIANTS

Evaluation of the cleaning episode in the variants

In the cleaning episodes there is a reduction of work to be done and decisions to be made from the first two examples to the third and a rising inflexibility in the usage. The reduction of work is paid for in terms of losing flexibility in the process. Depending on the needs of the customer, the assessment of flexibility and less work will be different, but with the variants it is possible to meet different types of customers.

	Customers effort in the process	Dependence on the provider
Reference case	++	--
Rented machine with full service	++	--
Laundry service	-	++

These results seem to indicate, that the more property rights the customer has, the higher is his flexibility in handling the system.

Due to the systematic variation of the property rights distribution, it is possible to design variants of the same PSS utility that all match the core benefit, cleaning laundry in our example, but also special extra utilities of different types of customers.

Evaluation of the effects of the broken machine on the customer

In the different variants of the PSS there is a significant difference in the effects of a broken machine on the

customer. The two ways in which the damage can affect the customer:

- 1 concerning his ability to get clean clothes
- 2 concerning his responsibility to change the situation and get the machine working again

In the **reference case** the customer is not able to get clean clothes with the PSS until the machine is repaired. Furthermore he has the full responsibility for the process. This leads to maximum lack of the utility of the PSS for the customer. With a bad reparation service situation, or a damage that can't be fixed, the loss is for a longer time up to a final loss of utility of the PSS.

In the case of a **rented machine** with full technical service, the customer only needs to report the damage and enable the service to get to the machine. The lack of utility only lasts for the duration of the defined maximum time span for repairing. If the repair service is unable to fix the machine, a working replacement will be supplied. The effort the customer has to make is small in this case and the time he can't use the PSS in the supposed way is limited.

In the **laundry service case**, the customer will not even notice if one of the machines is broken. It is the provider who has to arrange how to get the machine working again and how to reschedule the laundry jobs on the other machines. Therefore the customer has no lack of utility at all.

In the selected PSS cases a systematic reduction of property rights is performed. Starting with full ownership up to the right to make someone use the product for the customers utility. From the description above it is perceptible, that the less property rights and duties the customer has, the less he is in charge when problems come up.

Evaluation of the utility of developing and comparing episodes

The presented examples show, that it is easy to compare aspects of a PSS, when there is just a part of the PSS in a defined and therefore contrastable extent. The chosen way to define episodes of action appears to be a good choice.

It has to be pointed out, that the presented blueprints can be illustrating the final result of a development process. But they can also be the base to which further modification can be applied.

6 CONCLUSION

For systematic variation it seems to be helpful to include property rights as variable. But even if it is not used for designing variants, it is important to consider the existence of transaction costs and the opportunities of different types of property rights, as well as the problem of asymmetric information. With the knowledge about the theories of new institutional economy, the customers needs have to be focused. Only the maximizing of the customer value can change a good PSS into a better PSS, not the blind application of theories and concepts.

The knowledge about asymmetric information and transaction costs implies that it is more effective to design a good PSS that covers customer needs as well as the ability and willingness to pay the recommended price, than designing the best ever PSS that needs too much designing effort and is not affordable for the customers.

Designing the PSS in episodes and comparing the designed variants with focus on the episodes that are most important, looks like an appropriate way to get to a best matching solution. The information how to assess the

episodes can be taken from customer surveys, interviews or other marketing instruments.

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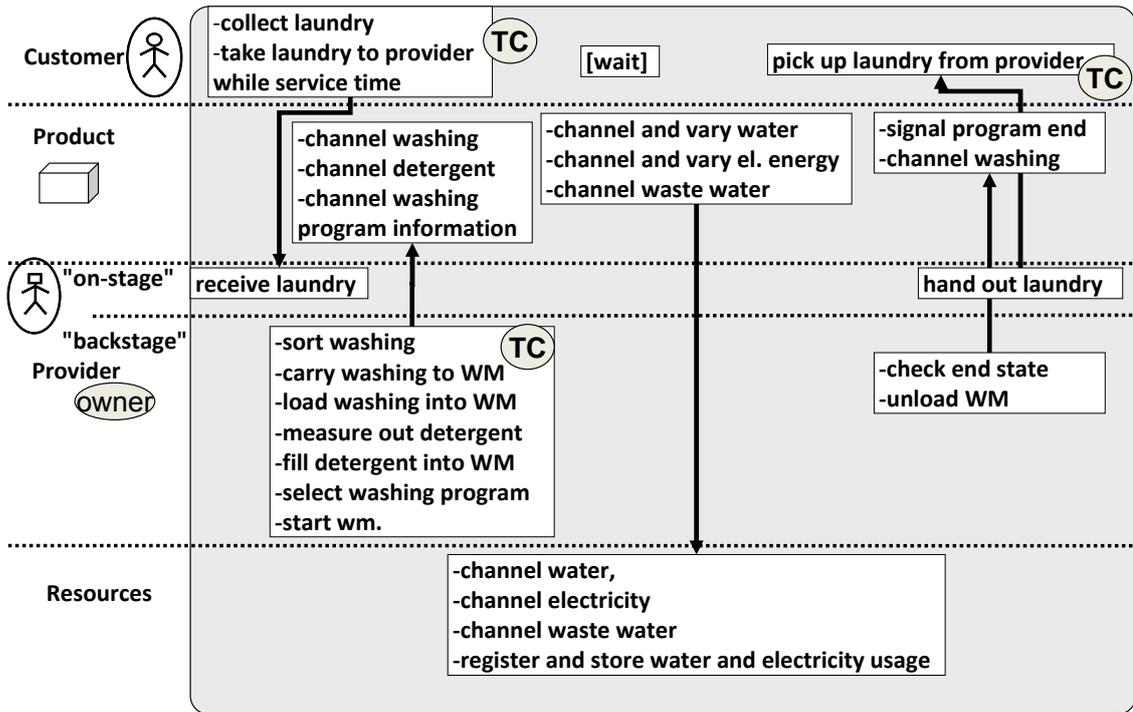


Figure 1: Case 'laundry service'

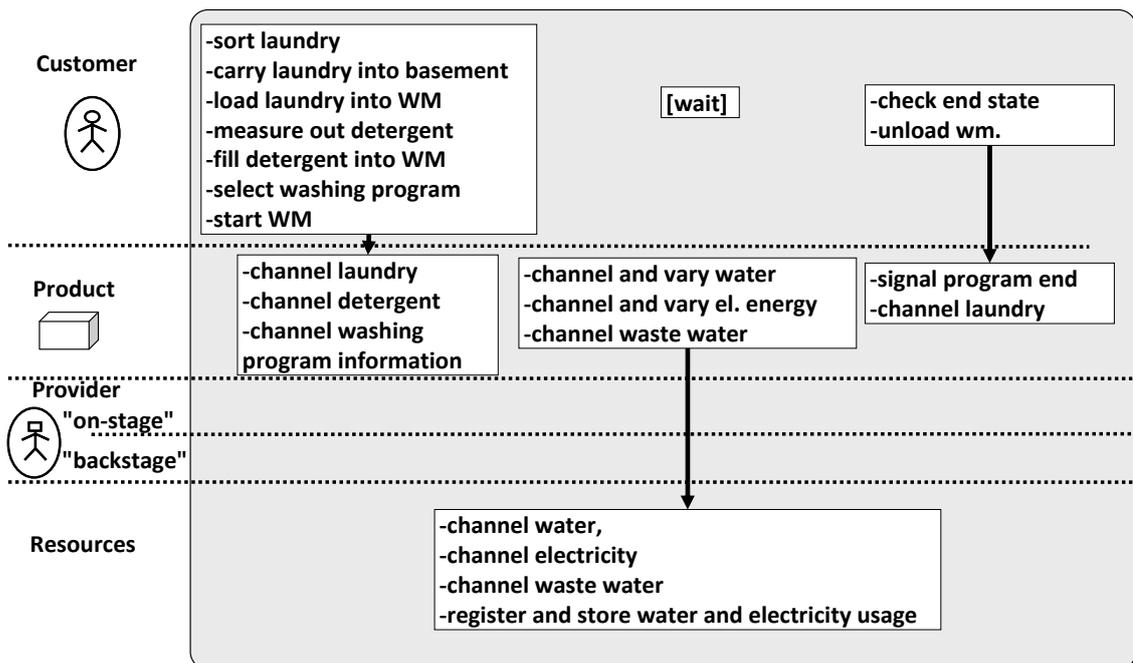


Figure 2: Reference case