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CHARACTERISTICS OF STRATEGIES IN PRODUCT/SERVICE-SYSTEM DEVELOPMENT

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1. Introduction

Over the past years a growing number of studies and research programmes have focused on the potentials of business strategies based on providing use value of products through integrated solutions of products and services – dubbed 'product/service-systems (PSS)'. The ever increasing global competition and demands for greater company responsibility of products throughout their entire life cycle are driving companies to consider business strategies other than traditional product oriented offerings, based on the transfer of ownership and responsibility from company to customer at the point of delivery.

By offering a combined product/service-system that continuously provides value to the customer, companies can develop innovative and individual solutions to attract customers and compete on the global market. The term 'PSS' is related and shared with other terms such as '*functional sales'* [Stahel 1997], '*functional (total care) products*' [Alonso-Rasgado et al. 2004], '*servicizing*' [White et. Al. 1999] and '*service engineering*' [Tomiyama 2001].

2. Objectives

Despite the numerous advantages to PSS business strategies that various studies [White et al. 1999] [Goedkoop et al. 1999] have shown, there are few existing examples of business strategies based on continuous life cycle improvements. By continuous life cycle improvements we mean here the active enhancement of both physical product and offered service, in an extended life cycle frame (incl. pre- and post-sales). Companies often lack knowledge and experience in actually developing solutions that are economically feasible [Mont 2004].

Limited research has been carried out in the design and development aspects of PSS. Designers usually focus their problem-solving skills on developing physical products, and not complete systems that also include intangible service components. PSS development therefore represents both opportunities and challenges for companies and designers to deliver different mixes of product and service elements in an integrated manner.

This paper identifies characteristics of various strategies that may be applied in PSS development. In design it has long been established that the evaluation of several alternative solutions before making a decision to implement aids in the identification of an optimal solution. Likewise by considering alternative strategies to PSS solutions, companies should be better suited to identify a strategy that fits their business context. This paper offers an overview of strategic characteristics that companies may consider when offering their product and services.

3. Identifying Product/Service-Systems

There is nothing new that companies offer products and services together. Every product involves services such as sales, delivery and support and every service involves physical products in order to provide the benefit. Seen in this light PSS is a metaphor, created by consultants and researchers, for an approach, which has been known and utilised by several types of companies for many decades: suppliers of aeroplane engines, large software installations, transport and logistic systems are a few examples of these. Tukker & Tischner [Tukker & Tischner 2005] identify three main PSS categories: 1) Product-oriented PSS, e.g. product maintenance and servicing contracts 2) Use-oriented PSS, e.g. car sharing, and 3) Result-oriented PSS, e.g. chemical management.
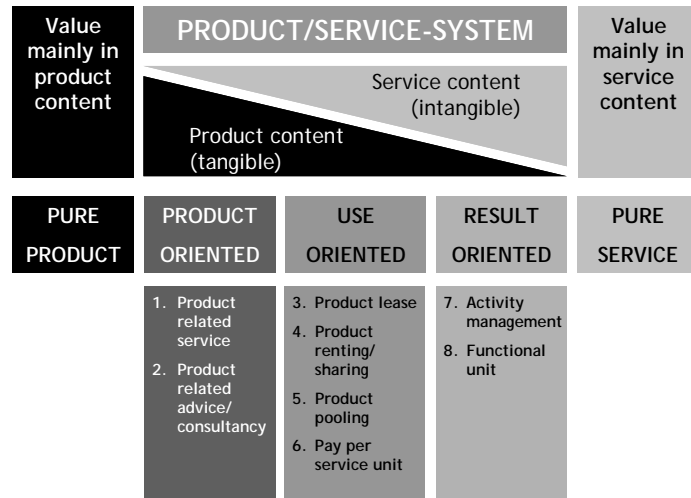

Figure 1. PSS categories [Tukker & Tischner 2005]

Here the focus on delivery of value to the customer is the distinguishing factor in Tukker & Tischner's categories. Furthermore the model inherently ascribes that a shift in business orientation from material products to immaterial services will motivate companies to increase material efficiency and reduce material consumption. This approach may lead to 'Sustainable Product/Service-Systems', designed to deliver value to the customer throughout the life cycle of the offering in an economically profitable, environmentally efficient and socially responsible manner. An underlying principle to PSS strategy is to shift from business based on the value of the transfer of product ownership and responsibility, to business based on the value of utility of the product and services. The customer thus pays only for the use of the product when needed and does not have to worry about operation, maintenance or disposal. This enables and motivates companies to reuse, rationalise and enhance their products and services more efficiently throughout their life phases. This strategy also allows companies to enhance their competitiveness by expanding features, value and benefits not apparent with traditional product-oriented offerings.

PSS provides incitement for more sustainable development as the physical products can be managed as valuable inventory that remains within the system and not just consumerables that disappear from the system. The greatest environmental impact of energy using products is in their use phase, where the use is totally at the consumer's discretion. Environmentally, this is not always an optimal situation, as the user has little knowledge of proper usage, or has different usage patterns that were not intended for the given product.

Tukker & Tischner's model is purely descriptive in the sense that it offers us a spectrum of variations of PSS in the singular dimension of value delivery, but does not provide us with knowledge of other PSS variations or the benefits of these, which are essential when designing PSS. PSS approaches are business strategies a company may use to offer a certain benefit to a customer. Companies employ a strategy as a plan of action to achieve certain goals, and in the same way products are designed and

developed, strategies are designed and developed. In design theory we distinguish between 'characteristics' and 'properties' [Mortensen 1999]. A characteristic constitutes something (i.e. it tells us what it 'is') and it determines the 'properties' of something (i.e. it tells us what it 'does') when related to a specific context. In order to achieve certain properties designers modify characteristics to better suit a specific context.

A characteristic of a strategy describes 'what it is', e.g. product ownership is retained by the company, but the effects of the strategy (its properties) depend on the context the strategy is applied to, e.g. customers value that they do not have to think about maintaining the product.

4. Methods

4.1 Description of PSS course

The base for this study of strategic PSS characteristics is a collection of student projects, based on PSS approaches. The student projects in PSS result from a dedicated course for fifth semester *Design & Innovation* Masters students at the Technical University of Denmark (DTU). The course, entitled 'Product Service Systems' (10 ECTS points), places the focus on learning techniques for considering the whole product life when designing and developing products. Through the project work the students are trained in identifying and analysing environmental issues in a holistic perspective; synthesising environmentally improved solutions to consumption needs; and developing strategies towards the realisation of these solutions. The course has run for two years at the time of writing this paper with approximately 55 students each year (totalling 34 projects).

4.2 Initial data-set: Design & innovation student projects

To start the PSS projects, the students were given a series of products to base their studies on. The students were expected to choose a product and organise themselves into groups of 2-3 people. For each year the focus of the project is changed by altering the products that provide the foundation for the course. For example:

- In autumn 2004 the products were chosen due to their common type of environmental impact – i.e. the usage phase. These products included: a lawn mower; washing machine; coffee vending machine; refrigerator; vacuum cleaner; laser printer; and an ink-jet printer.
- In autumn 2005 the products chosen were focused around food preparation and consumption in the home – i.e. a thematic focus. These products included: a dishwasher; charcoal grill; gas-fired terrace warmer; freezer; oven; cooking hob; and a food processor.

In an attempt to devise a normative approach to PSS development in the course, students are required to follow the steps listed below:

1. **Create a product life gallery** – *a graphical representation of the product's life focusing on the encounters with various life cycle systems and the environmental effects this causes.*
2. **Identify the functional unit provided by the product** – *based on existing theories for Life Cycle Assessment (LCA).*
3. **Carry out an 'Analysis, Diagnosis, Focusing and Goal-Setting' exercise** – *to take stock of and plan changes to the environmental effects.*
4. **Sketch the actor-network (the system), describing its nodes (the stakeholders) and the connections (value-chains, information chains etc.)** – *in order to fully understand the stakeholders involved in the emerging PSS).*
5. **Identify and sketch the customer activity cycle** – *a mapping of the customer's experience with respect to their needs satisfaction.*
6. **Describe the physical artefact(s) that are necessary to deliver the service-system**.

The final assignment in the course is a description of a concept for a new PSS with radically improved environmental performance. Here the students are asked to model the stakeholder network and their relations, explain the life cycle activities associated with the PSS and argue for the benefits for stakeholders as well as the environment.
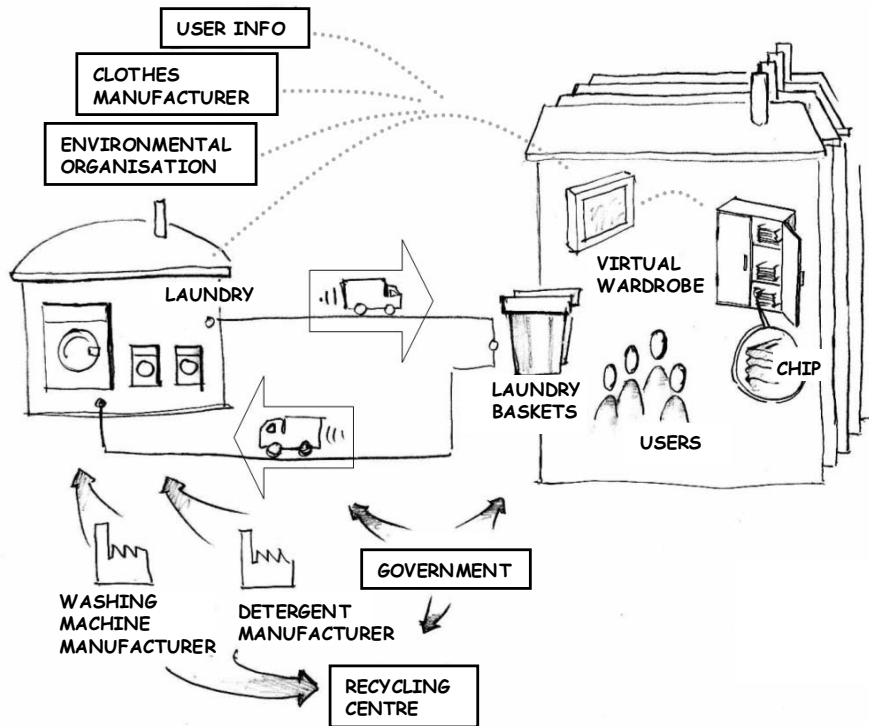
Figure 2. An example of a PSS concept description [Student project 2004]. A service that provides clean clothes in your home could replace washing machines. Dirty clothes would be picked up at your home at regular intervals and returned back clean and folded. The clothes would be tracked by a microchip tag sewn in that would contain washing instructions and user information. A virtual wardrobe would allow you to see what clean clothes you have, suggest what to wear or offer deals on new clothes to buy online

4.3 Empirical studies

Our study of the students' project work was based on the final project assignment. Here we reviewed the PSS concepts in order to identify the strategies developed or adopted by the students. The identified strategies were then grouped in to categories that described their characteristics. In the same way that a morphological matrix in engineering design shows a variety of alternative solution proposals, the characteristics of the strategies were lined up to show alternative strategies that could be considered for PSS development. Our intention with this exercise is to attempt to identify a morphology as complete as possible, built on an extensive number of empirical cases, so as to be able to begin to map PSS strategies and study emerging patterns in PSS development.

5. Results

The strategies applied by students in the projects varied in each their own way. For example some projects focused on the extension of product and/or service offers to better fit the customer needs, whilst other projects focused on the new types of value delivery through partnerships with other companies and organisations. By describing the strategy applied in each project, 7 characteristical dimensions were identified. Figure 3 shows various characteristics of PSS strategies and possible variations that companies may consider when developing a new system. Some of the variations of each strategic characteristic may be seen as along an axis in one dimension (e.g. 'Transfer of ownership'), while others show distinctive alternatives in multiple dimensions (e.g. 'Expansion of benefits').

Strategic characteristics	Variation A	Variation B	Variation C	Variation D	Variation E	...
Benefit is oriented towards:	Ownership of the physical product	Use of the product	Results of the use of the product	Consumption of the product	...	
Transfer of ownership	After delivery/sale	After installation	Returns to company at end of life	Is never transferred – owned by the company throughout its life	...	
Responsibility during use	Customer has full responsibility	Company is responsible for installing	Company installs, maintains and takes back the product	Company has full responsibility for the use of the product	...	
Management of life cycle activities	Company manages the specification, procurement and installation	Company manages the operation and maintenance	Company manages upgrading	Company manages continuous improvement	...	
Availability of offering	Always present at the customer	Present at the customer when needed (serial use)	Present at the company when needed	...		
Expansion of benefits	Core benefit alone	Multiple benefits aggregated together	Multiple benefits integrated with each other	...		
Economical value based on:	Transfer of ownership	Value based on per use	Value of the management of activities	Value of taking responsibility of the use	Value of the result of use	...

Figure 3. Characteristics observed in strategies in normative PSS approaches

In this paper we propose that by considering alternative variations of these strategic characteristics new PSS solutions became apparent for designers. Figure 3 gives an overview of possibilities (although it is not extensive). By combining the characteristics and their variations listed above a multitude of strategies may be conceived.

Figure 4 shows an example of how a strategy for a PSS concept is characterised. Starting with a washing machine, the students used 'clean clothes' as the functional unit provided and created a PSS for private customers where dirty clothes were picked up at their homes and washed centrally. Using Radio Frequency Identification (RFID) tags embedded in the clothes, the washing company could manage the whole system and even generate an online 'virtual closet' of the customer's clothes so that he/she would always know what was available to wear.
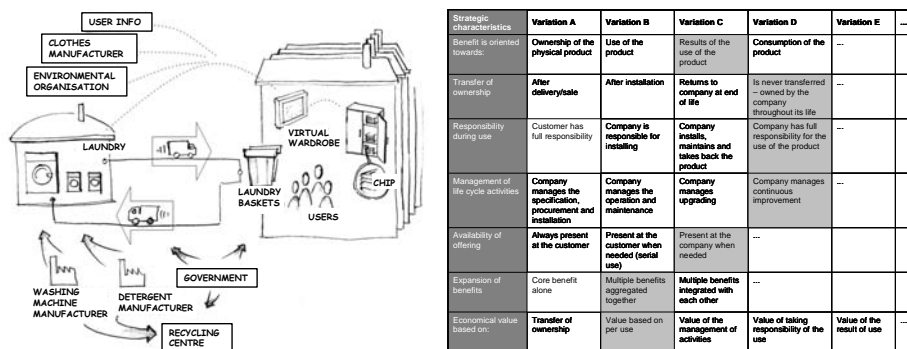

Figure 4. The 'clean clothes' PSS concept described by its strategic characteristics [Student project 2004]. The concept is based upon *results of use* of a washing machine, the *users do not own* the machine, the *laundry company has full responsibility for the use* of the product and *manages continuous improvement*, the *machine is located at the company*, *several benefits are aggregated together* in the service and the *user pays only for what clothes are washed*

In the conceptual phases of PSS development designers may vary the strategic characteristics in relation to the stakeholders and their context in an attempt to evaluate which PSS strategy would be the most appropriate for the company.

Each characteristic represents a different way of describing a strategy on its own; but characteristics are to a certain extent often interrelated. For example the economic value of an offer is typically mirrored in how the benefit is oriented, even though this is not always given. Some variations of the characteristics are better suited to others, whilst it is difficult to imagine the matching of others.

6. Discussion and implications

The design process can be seen as a process of selecting solutions that are well suited to a specific problem. Through analysis and synthesis designers consistently evaluate the elements of a design. By visualising the characteristics of PSS strategies designers may discover new degrees of freedom and opportunities not apparent within traditional business models. This shift in strategy allows companies to move competition beyond product-oriented parameters such as low unit cost, short product cycles and superfluous technical features.

Our intentions for a next step with this research are to verify if similar characteristics can be seen in existing PSS companies. Even though the base of the study is student projects, we believe that it is possible to find the same characteristics and their variations in existing companies and business models.

The seven strategic PSS characteristics identified in this paper may be applied by companies to achieve new positions on the market:

- **Benefit orientation** – Customer needs may be fulfilled in a variety of different ways. A revision of what is the customer's objective of using certain products and services allows companies to align itself with their customer's needs. E.g. a supermarket is not necessarily interested in how refrigeration components and controls work (*the use of the product*), they just want their cold storage kept at +5°C or -18°C (*the result of the product and service*).
- **Transfer of ownership** – Many products involve considerable investments even though they are only used infrequently. For many business-to-business companies, if the product is easily available the ownership of the product is not essential as material investments often depreciate rapidly. E.g. for construction firms a lot of the specialised equipment is *rented or leased* as the investments of purchase far exceed the value of use.
- **Responsibility during use** – Increasing technological advances have made many products complex and require specific knowledge to be correctly installed, operated and/or maintained. If the need for these activities is only occasional for the customer, then companies may offer to take upon the responsibility of the physical products. E.g. in many offices today outside service companies are *responsible for the installation, operation and maintenance* of the coffee machines.
- **Management of life cycle activities** – Products that involve orderly handling during their life, either due to necessary technical upgrades or environmental concerns, entail constant surveillance and meticulous documentation. Many customers would prefer to outsource these activities and instead focus their efforts on their core activities. E.g. most chemical manufacturers offer Chemical Management Services (CMS) to their customers that *ensure correct use, collection and disposal* of chemicals.
- **Availability of offering** – With the increasing integration of information and communication technologies (ICT) in products it is possible to interact with products in new ways over time and space. ICT also facilitates the organisation and coordination of sharing the same products. This allows more efficient use of products. E.g. libraries nowadays allow users to *check the availability* of books, CDs, DVDs, etc. online and also *reserve them* for future use.
- **Expansion of benefits** – Products usually only cater for one or a few activities. Instead of focusing on the activities surrounding a physical product, companies should focus on the activities surrounding their customers. Even though the product might provide a core function there are often activities before, during and after the use of the product that are just as essential to the customer. Companies may discover business potentials by aggregating and/or

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integrating how these activities are supported. E.g. For diabetics, insulin provides the core benefit, but a *whole range of factors come in to play in the customer's experience*: reminding the customer of when to take insulin, figuring out when to eat, measuring the glucose amount in the blood, noting how much insulin was delivered, etc. and all this whilst the customer might be in a public social setting.

- **Economic value model** – It is given that in order for companies to exist the costs of manufacturing and delivering products or services have to be covered by the sales price, but how this price is constructed or determined is not necessarily given. Instead of one time payments, companies may structure their sales to customers in different ways. Payment might be based on the availability of the product and/or service, based on how often the product and/or service is used, based on the end result of the use of products and/or services or even based on collateral for other valuable entities. E.g. in many cities the design, installation and maintenance of bus stop shelters are *paid for by companies in exchange for* exclusive rights to outdoor advertising space given by the city council.

The mapping of PSS strategic characteristics allows new ideas to flourish. However it still leaves the challenge of navigation through the many possibilities as a task for designers. As with all design, knowledge of the stakeholders' context, needs and values, the social and technological possibilities and what is feasible for a company are all guides in creating a good solution.

A change in business strategy also changes the way companies perceive their development activities. PSS approaches call for increased integration of the development activities within a company or within a network of companies, but how these development activities are to be coordinated and managed still needs further investigation. It seems as if business strategies based on continuous life cycle improvements are possible, but we have yet to gather more experience in how this is actually done.

7. Conclusion

This paper has identified typical characteristics of strategies used when developing PSS. A normative method on how knowledge of PSS strategies may aid designers to develop new and innovative PSS solutions is introduced.

Our study is based on student projects and although a company context is simulated during the projects, this approach has yet to be verified in a company context. It is our objective to develop a comprehensive PSS strategy matrix, so as to be able to map and thereby identify a series of different PSS strategies. This identification of PSS strategy types will give us the opportunity to develop methods and approaches to PSS development, more tailored to specific business strategies. Our work with this next step has begun and we are currently preparing company cases for building into the morphology.

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