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Product-Service Systems across Life Cycle

The Sustainable value proposition of PSSs: the case of ECOBEL “Shower head”

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Abstract

Product/Service Systems are conceived to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models. Based on a single case study, this paper analyses the specific sustainable value proposition that a company has designed to replace a low-cost product by an innovative Product Service Solution. The objective of the company is to replace the “shower head” in every hospital room. The concept that was developed does not consist in replacing product “A” by an equivalent product “B”, but in changing radically the offer. The Product Service Solution includes a lifecycle analyses, by integrating environmental social and economic impacts into the different main phases, i.e. beginning of life (BOL), Middle-of-life (MOL) and End-of-life (EOL). Even though the product that was designed to support the service looks very simple, the design of this innovative solution highlights the role of the functional analyses to be more environmental friendly, to improve social issues and finally proposes a new business model based on servicisation. The “shower head” as a service developed by ECOBEL is far beyond the low-cost product used today in the French hospital, by integrating a new sustainable value proposition.

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1. Introduction

To face the huge competition driven by cost reduction, an increasing number of companies have started extending their value proposition by providing services in addition to their products: designing “products and services” that provide consumers with the same level of performance, but with a fundamentally lower environmental impact. The combination of physical products and corresponding services is “designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models” [1] that is to make the right “balance between environmental, economic, and social concerns” [2]. For that reason, the benefit of product-service combinations is not only considered on the economic side but, from different types of added value [3] [4].

But in a recent literature review, Tukker points out that PSS is not the sustainability panacea [5]. His conclusion is that “Product-oriented” PSSs do not change the incentive to maximize product sales. “Use-oriented” PSSs potentially intensify the use of material products and hence could reduce the need for materials, but a possible drawback is that they could prompt less careful use, leading to quicker wear and tear. “Result-oriented” PSSs have the greatest potential and provide an incentive to reduce material costs but require the most radical change in the business model compared with product sales.

Based on a single case study, this paper analyses the specific sustainable value proposition that a company has designed to replace a low-cost product by an innovative Product Service Solution. The objective of the company is to replace the “shower head” in all hospital rooms. The concept

that was developed does not consist in replacing product “A” by an equivalent product “B”, but in changing radically the offer.

Based on a lifecycle analysis, the purpose of the paper is to investigate the different dimensions of the sustainable value proposed by this PSS. As sustainability is the main concern of this PSS innovation, this paper integrates environmental, social and economic dimensions, as well as a wide range of stakeholders and various time horizon perspectives.

The remainder of this paper is structured as follow. After a description of the research methodology, the first part of the first part of the paper will introduce the different phases of product and service lifecycle, as the concept of product-service systems is a new paradigm to sustain economic growth while reducing life cycle environmental impacts. We then give an overview of the concept of value proposition in the context of sustainable development. Finally, based on a case study analysis, the paper shows the sustainable value proposition that has been developed by ECOBEL’s Product-Service System.

2. Research Methodology

This paper is based on an exploratory research. The choice of a single case study presents the interests to study a single situation in-depth, anchored in the reality and multiple levels of analysis such as individual, firm and society [6]. In order to increase the validity and the reliability of our results, the empirical data come from different sources: individual interviews with the manager (face-to-face in-depth interview and phone), mail exchanges, external sources (medias) and internal documents (personal and institutional documents). Based on Eisenhardt [7], we have adopted an iterative process between our results, research question and literature. We have systematically submitted our point of view for the case manager’s approval to avoid misinterpretations and discuss the results. Interviews were taped and transcribed before analysis, which allowed the emergence of the theme.

3. Product and service Lifecycle

The term ‘lifecycle’ generally indicates the whole set of phases, which could be recognized as independent stages to be passed/followed/performed by a product, from ‘its cradle to its grave’. Adopting an easy-to-use model, product lifecycle can be defined by three main phases [8]:

- **Beginning of life (BOL)** including design and manufacturing: identifying requirements, defining specifications, doing a more and more detailed design, developing prototypes and performing tests, and finally manufacturing.
- **Middle-of-life (MOL)** the product is in the hands of the customer, who uses it, and is supported by the manufacturer or providers for maintenance. It also includes external logistic, distribution.
- **End-of-life (EOL)** the product is retired or upgraded by the manufacturer and disposed by the customer. Products are retired in order to be recycled. EOL is the phase where

products are collected, disassembled, refurbished, recycled, reassembled, reused or disposed.

In fact, products have changed their meaning and composition: they are now complex systems, composed of tangible core (the physical product) and a series of intangible assets like services provided to customers. As indicated in [9], Service Lifecycle Management is a little bit different, as service needs to be implemented at the customer location. The three main phases of the Service Lifecycle are service creation, service engineering and service operations management:

- **BOL and Service Creation** mainly consists of two pillars: provision of conditions and ideation. The influences providing opportunities may be changing customer needs, new emerging technologies, transformations of the company environment, and other causes or drivers of change. For service ideation, they serve as triggers or stimuli. When a selection of service ideas is handed over to the first phase of service engineering, it comes to a structured evaluation of the service ideas based on market and technical requirements.
- **MOL and Service Engineering** consists of four phases: service requirements, service design, service implementation and service testing. The service should be tested by customers or by using a simulation tool or at least by a checklist.
- **EOL and Service Operations:** the service needs to be delivered to the customers (service delivery). The support activities for service operations are also important, here for instances to evolve the service portfolio and to control the service operations.

The ability of industry to enable such holistic products and supporting services is currently limited by the information gap in the products lifecycle [10], as well as information losses and bottleneck [11]. Based on the admission of failure to integrate Product Lifecycle Management (PLM) and Service Lifecycle Management (SLM) approaches, Wiesner et al. [9] have proposed 4 kinds of interaction between PLM and SLM:

- **Alternative A:** the Service Lifecycle Management is triggered by the Product Lifecycle Management. The management of the service life cycle happens according to the changes of the PLM.
- **Alternative B:** where PLM depends on SLM. The main focus is put on the management of the service lifecycle. The management of the product lifecycle happens accordingly to SLM.
- **Alternative C:** adjustments take place on both sides. Mostly, the product and the according service life cycle are the same length but the interactions take part only if they are necessary.
- **Alternative D** would be a thorough integration of PLM and SLM, where both lifecycles are managed in a highly integrative way, so that the separating managerial boundaries between PLM and SLM “disappear”.

As suggested by [10], it is expected that PLM will support value creation in the society through enablers in the following areas:

- **Technical:** optimal accomplishment of the expected functions covering the user's expressed and unexpressed needs, exploiting field knowledge gathered through the product lifecycle.
- **Economic:** creation of value for the producer, for the service provider and for the product owner.
- **Social:** delivering comfort, safety, security and satisfaction to the product user (e.g. the passenger of a bus, the user of an elevator, etc.).
- **Environmental:** minimization of pollution, of resources and energy consumption by applying optimal BOL, MOL and EOL planning.

4. Sustainability, stakeholders and value proposition

Value is a multi-perspective concept that extends beyond the limits of the firm. Over the last decade, many authors [12] [13] [14] called for an urgent renewal of the strategic objectives of firms, towards financial success, but taking into account the actual needs of the communities. There is now a well-recognized need for achieving overall sustainability in industrial activities, arising due to several established and emerging causes: diminishing non-renewable resources, stricter regulations related to environment and occupational, safety/health, increasing consumer preference for environmentally-friendly products, etc. [15]. For those reasons, many companies have adopted the concept of sustainability in their strategy. It refers to an integration of three pillars: social, environmental and economic responsibilities [16]. The most used and quoted definition of sustainability is that of the World Commission on Environment and Development (1987): "development that meets the needs of the present without compromising the ability of future generations to meet their needs".

It implies for companies to redesign their business models, integrating end-of-life products by designing collection and reverse logistics, by increasing circularity of flows from cradle to cradle, by reducing energy intensity to create a sustainable value. With globalization and technological innovations, value is delivered through dynamic networks of interconnected firms or supply chain. The strategic models of Value Creation based on arms-length confrontation with suppliers has led many companies on a short term value creation path, based on low cost, low quality products.

Value is a multi-perspective concept that extends beyond the limits of the firm and there is now an increasing pressure to consider the environmental and social aspects and expectations are rising from different stakeholders such as customers, suppliers, general public, NGOs, and governments.

Common to all of them is the reference to companies' voluntary contributions to positively influence the present and future relationships with stakeholders [15]. It advocates the idea that companies need to change their business models and value propositions, actually creating value not only for themselves, but also for a larger number of stakeholders. The

importance of the question of the stakeholders resides in the fact that, just like the notion of Shared Value, Societal Value, the value created by the firm can be defined through the stakeholder for which it is created. The stakeholder theory is well-used in the context of PSSs by understanding the relation network and the interdependence of three main groups: customers, company and society [17] [18]. Creating sustainable value involves the collaboration and the satisfaction of internal and external stakeholders, beyond customers and shareholders. The benefits on the environmental and social dimensions hold the firm to consider the value for stakeholders on the short term and on the long term [19]. The *value proposition* is a strategic concept that allows firms to better analyze and describe their skills and capacities, on the strategic as well as on the operational levels [20]. Value becomes a value proposition according to the stakeholders it is developed for [21], the value proposition being the implicit promise that a firm makes to its customers to provide a combination of values which links two different visions of value: *Internal* and *external*. The deployment of the concept of Value Proposition has a significant impact on operational models of firms [22]. The value proposition of PSSs relies on its ability to target needs and wants of each stakeholder, which can be conflicting [17] [19].

Product/Service Systems offer new perspectives for value creation and differentiation in manufacturing. Therefore, the identification and characterization of the value systems of the stakeholders of the solution are fundamental when trying to improve the benefit of an existing, well-known product. The adoption of an innovation in a company, like a PSS, involves a heterogeneous set of entities along the value chain and its ecosystem: purchasing department, maintenance, accounting, customers, society, etc. Each member has its own set of values. The Product Service System must be aligned with all of them, as one of the main obstacle to the adoption of these innovative solutions comes from a misalignment of values [23]. Since values perceived by the different entities are one driver of the adoption of PSSs, this paper explores the sustainable value proposition of the ECOBEL Shower head.

5. Case study

The case study is based on a very simple product, a "shower head" and the market is mainly concentrated on hospitals and health care facilities. In each hospital room, there is a shower with a shower head that needs to be installed, cleaned, and maintained so that it complies with the requirements of regulation and patient safety.

In most of the cases, this shower head is today a low cost product with a very low level of traceability. Ecobel, a French SME, has decided to develop a serviced shower head for this specific market. As a starting point, the core competency of the company relies on water saving devices. By designing this solution its target is to replace the existing shower heads in hospital rooms, considered as very low cost commodities, by an innovative one, sold as a service. The main objective of the company was to design a serviced system that is cheaper (from a total cost of ownership point of view), more environmentally friendly, and that facilitates traceability and maintenance. Another issue concerns the patient security and

safety by preventing bacteriological health risk.

The adoption of such a disruptive innovation relies on the identification and characterization of the value systems of the stakeholders of the solution. In that case, there is an heterogeneous set of stakeholders involved in the decision process or impacted by the choice. Stakeholder's identification and the value integrated in the PSS shower head analyzed in this paper is mainly based on face to face interviews with the project manager of this solution who is also the director of ECOBEL, and other internal and external documents. The main barrier to the commercialization of the proposed PSS lies in the difficulty of its value perception and to convince potential customers of it [24].

5.1. Stakeholders identification

Moving from the sourcing of a low cost commodity, very well-known and easy to do, needs to convince a lot of people involved in the decision process. It's not only replacing one product by another one, it will also change the process, the evaluation model, the skills and competencies of people, etc. Coming back to the specification of the solution, this will help understanding the decision ecosystem: cheaper, more environmentally friendly, that facilitates traceability and maintenance and prevents bacteriological health risk.

Security

According to ECOBEL investigation, shower head is one of the main vehicle of contamination for legionella in healthcare facilities. The **patient** of course is the first target, as he came to hospital to become healthy, not to get a nosocomial infections. But not only the patient, because it is the responsibility of **Hospital director** to guarantee patient safety by ensuring that healthcare products meet appropriate standards of safety, quality, performance and effectiveness. The **hygienist**, chief officer of health, is in charge of the compliance of the equipment to patient security. He has to evaluate innovations coming from the market to decide whether or not adopting them, especially if it can improve patient safety.

Traceability and maintenance

Showers in hospital rooms have to be maintained in good operating condition. They are replaced every years by the **technical staff**. This needs to be scheduled, the rooms have to be empty, and this requires the coming of a technician in the medical area, with all the procedures and risk associated to this situation. This exchange should better be done by the medical staff, such as **auxiliary nurses** or care assistant.

Furthermore, the **hygienist** needs to guaranty the traceability of the maintenance and exchange of the shower heads that is not so easy with the low-cost shower head, even if some procedures normally control that point.

Sustainability

The middle-of-life of the product has to be considered here as shower means water consumption. The impact on water resources becomes a huge question in many countries that concerns **people, society, local policies** on water regulation, but also the accounting department.

The End-of-Life of the shower head has to be considered. Actually these products are normally replaced every year and their incineration generate pollution and many toxic substances. Two stakeholders can be identified regarding that target area: people living around incinerators and more widely **society**, but also the **accounting department** of the hospital, as the cost of incineration is increasing every year.

Economic issue

The economic issue is a very important topic but on the whole budget of a hospital, it is not seen as a priority. The cost can be divided in 4 parts: buying the product, using the product, maintaining it, and destroying. Due to hospital organization, these cost items are not under the control of a unique department. Buying the product is made by the **purchasing department** and in most cases the lower price is the better one. The cost of using the product is mainly based on water consumption. This is considered as operating expenses, under the control of the **accounting department**, and not easy to separate from the whole operating expenses. Maintaining, tracking and changing the product is a hidden cost for the **maintenance department**. Destroying it is also an operating expense difficult to isolate in the total cost of the destruction of the waste hospitals produce.

5.2. Sustainable value proposition

Security

The objective here was to minimize the bacteriological health risk due to the legionella. The legionella is a bacteria that develops at the terminal point of the water supply, here the shower head hand, and that is transmitted to the patient by the water spray. The design of the product was made so that the product is modular, sleek and minimalist, so that it minimizes the area where the bacteria usually develops. The stagnant branch of the shower head is at its minimum length so that the contamination of the head is reduced almost to zero. The final design integrates ergonomic and easy to make issues (fig. 1).



Figure 1: final design of the shower head

Traceability and maintenance

To facilitate installation, a plug and play solution has been designed so that you do not need any tool to connect the shower head. Anyone can do it, you do not need any more the technical staff to be there. Maintenance is facilitated by a modular approach of the product, so that you can repair it and replace some components.

To facilitate traceability, a visual identification has been added with the aid of component color. As showerheads need to be replaced every year, a colored component has been

integrated in the design so that the year of installation is linked to the color. Traceability of installed products is facilitated in the patient room as it does not need any complicated procedure to check replacement, but is evident at first glance.

Sustainability

Many improvements have been made when designing this solution to increase sustainability. The design of the product has integrated modular components and the use of recyclable raw material. The product can be produced with different configurations, depending of the assembly of the components. One configuration has for example integrated 50% of wood floor. The last generation will be available on a 3D printer.

The product was designed so that it minimizes water consumption, while keeping a good feeling for the patient when he takes his shower. Last point concerns disposal and reuse of the shower head. As it is now a service, the product is collected back by ECOBEL to be disassembled. As it was designed as a modular product, the components have been classified, depending on the kind of raw material they use. When recycling, some components can be reused or grounded to be reprocessed as raw material.

Economic issue

This one of the main obstacle to its adoption by hospital. Today the cost of such a basic product is very low, only few Euros. The targeted price of the ECOBEL solution is far more expensive if you only look at the price to pay per shower head. The economic issue is based on the Total Cost of Ownership (TCO) of the solution. TCO needs to be incorporated in the financial benefit analysis to determine the total economic value of this PSS. The benefit relies on the water reduction consumption so that it is, at the end, far cheaper than the basic shower head used today.

Another benefit lies on the hidden costs reduction due to the modification of the installation/removal/tracing process. It does not need any more the technical staff, the schedule is simplified and traceability is facilitated.

5.3. PSS lifecycle and Value proposition

The value created by this PSS approach can be split along the lifecycle. The solution was designed to be more sustainable so that the value proposition of ECOBEL solution adopted a multi perspective approach. The value proposition takes into account the three aspects (environmental, economic and social) of PSSs in regarding of the concept of sustainability in its strategy [13] at the three phases of lifecycle [8]. With its business model, ECOBEL provides a sustainable offer throughout the entire lifecycle: from the design and creation to the usage, maintenance and the disposal. Furthermore, as previously explained, it has also developed a multi-stakeholder value proposition to maximize its adoption by the market. The ECOBEL solution can be considered among sustainable innovation strategies in a total lifecycle perspective [25]. It creates added value for the hospital (customer), society and patient (customer to its customer), as we can see in the following tables.

Table 1: Value proposition at the Beginning Of Life

Value proposition	Stakeholder	Eco	Env	Soc
Raw material	Society		x	x
Modularity	Society		x	
Color code	Technical staff	x		
Bacteriological risk	Society			x
	Patient			x
	Hospital director	x		x

Table 2: Value proposition at the Middle Of Life

Value proposition	Stakeholder	Eco	Env	Soc
Water consumption	Accounting dpt	x		
	Society		x	
Easy to install	Technical Staff	x		
Easy to maintain	Maintenance	x		x
Traceability	Hygienist	x		x

Table 3: Value proposition at the End Of Life

Value proposition	Stakeholder	Eco	Env	Soc
Easy to Recycle	Society	x	x	
	Hospital	x	x	
Reuse of component	ECOBEL	x	x	

ECOBEL offers to its stakeholders both tangible and intangible benefits. Some of them are easy to understand because of similarity in products. It's about physical characteristics of the product, such as color code, raw materials, traceability. The customer can compare the solution ECOBEL with competitive shower heads and evaluate the superiority of the solution. The prototype created by 3D printer shows these to the hospital. However, for other elements of the solution value, the comparison is not possible or more complex. For instance, the bacteriological risk, water consumption, the easy to use and recycle are key factors in the value proposition but not integrated in the low-cost product proposition. These new features constitute an added value, which is more global, intangible and in the long-term perspective. The benefits are neither direct, discrete, nor based on the price of the transaction. The customer (the hospital) can gain positive effects on intangible resources. Positioning the hospital with sustainable values may improve the consumer perception of quality and so enhance the reputation or the corporate identity. These benefits result in an increase in the number of patients and economic benefits.

Furthermore, the hospital would purchase the shower head at a local supplier, which is better for the society (and political governments) from the economic and social values (create employment) and the environmental value (minimization of pollution due to international transport).

Several members of the hospital are concerned by the purchase and implementation of the ECOBEL solution. The director, the staff (technical and maintenance, hygienist) and the accounting department do not share the same benefits (values) in different phases of lifecycle. The final solution takes this into account and is more suitable for the customer. It also raises problems of display of the offer and the customer's decision-making. It implies that the hospital has the resources and the skills to study the proposition. As in many disruptive innovation cases, its adoption is still very limited due to the reluctance of the purchasing department.

6. Conclusion

The conclusion of the paper is that the "shower head" as a service developed by ECOBEL is far beyond the low-cost product actually used in the French hospital, by integrating new sustainable value proposition. The service, being flexible, can deliver new functionality to better suit customer needs.

The sustainable value proposition brings to rethink the business model, compared with the knowledge, the practices and the definition of the value [26]. The case ECOBEL stresses the importance of the economic and non-economic (environmental and social) benefits for the three stakeholders: society, customer (hospital) and consumer (patient). Facing the restraints of the hospital in the adoption, the development of the service requires to widen in other stakeholders and to foresee the value of the offer under societal value.

Even if ECOBEL solution seems to bring a higher performance level, there is still a very low adoption rate. The barriers to its adoption, compared to competitive low cost products can be classified on three dimensions:

- Large set of stakeholders: as the value proposition is spread out over various stakeholders, the benefit for each of them does not seem to be sufficient to change the model.
- Different perspective for value creation: hospitals, like other companies are more focused on the price of transaction, integrating in some cases a TCO analysis. But the environmental and social indicators are difficult to integrate in the decision process.
- Various time horizon: value can be created on the short, middle and long term. Decision makers are more sensitive to short term value creation, while other stakeholders such as society for example are more interested by long term value creation.

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