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Sustainable product-service systems for an office furniture manufacturer: How insights from a pilot study can inform PSS design

Filipa Costa^a, Sharon Prendeville^b, Katharine Beverley^{a*}, Giulia Teso^c and Chris Brooker^c

^a*Ecodesign Centre, PDR, Cardiff Metropolitan University, Wales CF5 4BY*

^b*Intent & Purpose, London*

^c*PDR, Cardiff Metropolitan University, Wales CF5 4BY*

* Corresponding author. Tel.: +44-29-202-5581; E-mail address: kbeverley@cardiffmet.ac.uk

Abstract

This paper reports on a project in which service design principles and LCA are brought together to conceptualise sustainable PSS models for an office furniture design and manufacturing company. Lessons learned from a pilot study in which a take-back scheme is being retrospectively developed for a popular office chair are used to develop two theoretical models (a product-oriented PSS and a use-oriented PSS) for a new product being developed by the company in conjunction with a local ECO-WISE. The paper discusses how merging service design tools with LCA can inform the PSS design from economic, environmental and social perspectives.

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1. Introduction

PSS business models have received increasing academic attention over the last twenty years. Tukker [1] defined PSS as “tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs”. PSS models span a continuum from total product to total service, depending on those customer needs [2]; however, when designing and implementing PSS models within organisations it is useful to be able to provide broad typologies for reference. These are most commonly based on the degree to which the service replaces the product. Tukker and Tischner [3] described three types of PSS: product-oriented systems in which the ownership of a product is transferred to the consumer and optimized through the provision of additional services such as maintenance contracts; use-oriented systems in which ownership of the product remains with the service-provider and the consumer

Nomenclature

ECO-WISE	ecologically-oriented work-integrated social enterprise
EOL	end-of-life
LCA	life cycle assessment
PSS	product-service system

purchases the product function through, for example, leasing systems; and results-oriented PSS in which product sale is replaced by sale-of-service and the consumer may not encounter the tangible product (examples include answering services on mobile phones and video streaming websites). Although the subject of academic critique and expansion, these classifications remain the most broadly adopted.

The potential for PSS models to encourage sustainable resource use has been discussed at length [4,5,6]. However, Tukker and Tischner [3] highlighted that PSS implementation does not automatically mean improved sustainability. Achieving environmental gains requires careful PSS design.

If a PSS is additionally intended to provide social benefit, the situation is further complicated. According to Chou *et al.* [7], far more literature exists on PSS models oriented towards environmental value than those oriented toward value across the triple bottom line and although there are a number of studies which describe frameworks for the evaluation of sustainable PSS models (see, for example, [6, 7, 8, 9]), their implementation on the ground remains limited. This paper discusses the conceptual design stage of a sustainable PSS for an office furniture design and manufacturing company, building on the lessons learned in the ongoing development of a take-back scheme delivered in partnership with a local ecologically-oriented work integrated social enterprise (ECO-WISE). ECO-WISEs are not-for-private profit ecological businesses providing employment for the long-term unemployed. It has been suggested that such organisations could make a significant contribution to sustainable business operations [10].

2. Pilot take-back scheme

2.1 Focal company

The focal company is a UK-based office furniture design and manufacturer. Its mission is to become the UK market leader for contemporary office and contract furnishings. The company is primarily concerned with business-to-business and business-to-government transactions in four key markets; corporate, education, hospitality and public sector. The company rarely sell direct to their customers, but have a network of established dealers.

The focal company is internationally recognized for its good practice in sustainable design. Product innovations include a chair designed for a closed-loop system. The company operates an in-house product take-back system that is free for the closed-loop chair and affordable for its other products. Products returned via the take-back scheme are not refurbished; they are either passed on to a local charity for reuse or disassembled and recycled via the appropriate channel. To date, uptake of the take-back scheme has been low.

2.2 Pilot take-back scheme overview

The pilot study is based on a popular office chair that has sold approximately 300,000 units since its launch in 1999. The chair was not designed specifically for disassembly and recycling. Nonetheless, 98% of the chair is recyclable. Currently, less than 1% of the chairs in circulation enter the focal company's take-back scheme.

The pilot take-back scheme involves collection of the chairs from a major corporate client for refurbishment/remanufacture and resale by a local ECO-WISE. The take-back scheme cannot formally be described as a PSS as the combination of product and service was not pre-defined before point-of-sale. However, analysis of its development provides valuable insight into the realities of working with an ECO-WISE.

The focal company has identified that public sector organisations with green procurement strategies are the most likely customers for the remanufactured chairs. Figure 1 shows the material and information flows taking place between pilot study stakeholders.

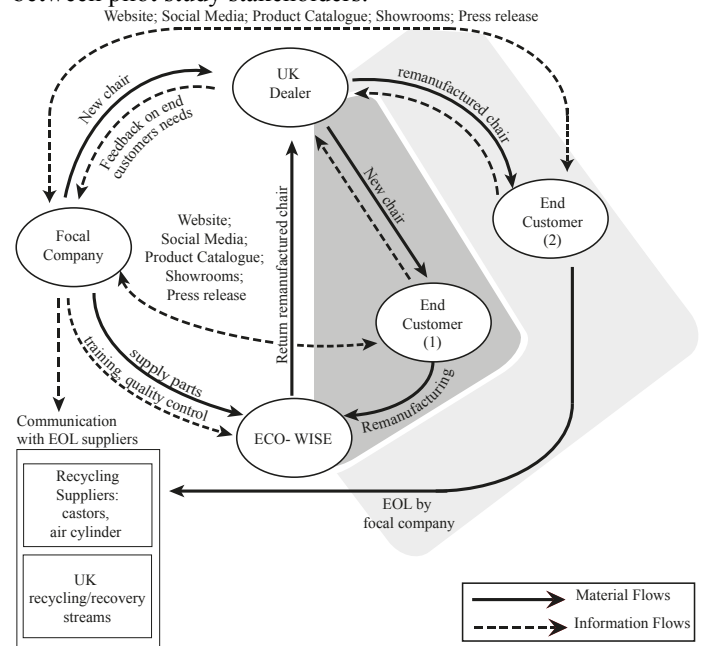


Fig. 1. Material and information flows for the pilot case

2.2 Benefits and challenges to working with the ECO-WISE

From the point of view of the focal company, there are several benefits to working with the ECO-WISE on the take-back scheme. The company's track record in sustainable design is very strong and the take-back scheme would provide further evidence of their commitment to environmental product stewardship. The relationship with the ECO-WISE would also strengthen the company's commitment to the triple bottom line approach through actively working with a social enterprise. On a more general level, the focal company employs just-in-time manufacturing methods and is not equipped for handling excess stock; initially, it appeared that the involvement of a third party would remove the responsibility for storage and refurbishment or remanufacturing, allowing the focal company to remain focused on its core business activities.

However, the pilot study has revealed some barriers to working with the ECO-WISE. They are experienced in furniture remanufacture and refurbishment, but are currently sell into a market that does not expect comparable quality to the original product; however, for the focal company, refurbishment to the best possible standard is crucial. The ECO-WISE staff have very specific training needs and these will need to be met by the focal company if the project is to be scaled up. They also lack remanufacturing equipment and do not have the means to purchase it. Therefore, the focal company will need either to carry out some of the remanufacturing at their own facility, or support the ECO-WISE in purchasing the relevant equipment. Transfer of the chairs from the first customer to the ECO-WISE and

product-oriented PSS, the outright purchase of the product at the onset means that the PSS contract is more advisory in nature, explaining how the best benefit can be gained from the chair. From a material stewardship perspective, there are significant benefits to the introduction of a use-oriented PSS. A product-oriented PSS is much less predictable in terms of material flow than a use-oriented PSS. Problems arise in recovering the chairs at end-of-life; the company is reliant on their customers being motivated to return the chairs at two points in the overall lifetime. The low uptake of the company's current take-back scheme highlights that customers do not currently have sufficient incentive to return chairs. If the chairs are not refurbished and remanufactured at the appropriate times, it may become economically unviable to undertake the process. The product-oriented PSS is also likely to galvanise competitors into offering alternative solutions for the customer in order to minimize the potential of the customer developing a strong relationship with the focal company; competing take-back schemes may arise that, depending on their level of success, could cancel out the resource efficiency gains for the focal company, in addition to the associated loss in profits. Such competition would also make the material flow for the ECO-WISE unpredictable. However, at this point it is worth noting that the company, when considering PSS design, has repeatedly expressed concern about entering into a use-oriented PSS. The company is concerned about the market appetite and dealer and sales team commitment to a use-oriented PSS. Discussions with the focal company's design manager have revealed some of the basis for these concerns. The company has a very experienced sales team, adept at dealing with sale of product; however, they have limited experience of sale of service. The sales culture of a company has been shown to have a significant impact on the degree of sustainable PSS implementation [12]. Although the focal company has undertaken some preliminary research that indicates that the public sector might be more disposed to the uptake of a use-oriented PSS, they require further evidence to convince them that there is a market. In the case of the dealer network, it is necessary for the dealer to be confident in selling the use of the chair, which means that they must be convinced of its attraction to their customers. Otherwise, dealers may promote competing products over the new product.

The exact form that the PSS will take is currently unknown; however, it is clear from this discussion that it requires careful design in order that it achieves its aims. The rest of this paper is dedicated to discussing the design process developed to support the company in choosing the PSS, beginning with a discussion of how sustainable PSS may be evaluated.

3.1 Indicators for the assessment of sustainable PSS

Assessing the sustainability of a PSS is not straightforward. Chou *et al.* [7] have suggested multiple criteria for assessing sustainable product-service efficiency. Their proposed hierarchy is reproduced in Figure 3.

In considering the factors contributing to the customer perception of the chair, the tangible criteria are the sole

responsibility of the focal company, and align well with their core competencies. Classic design principles have been applied to the chair and the prototypes are both beautiful and functional. Interaction criteria apply to interactions between the customer and all stakeholders; chairs are typically sold by dealers and the refurbishment is proposed to be undertaken by the ECO-WISE.

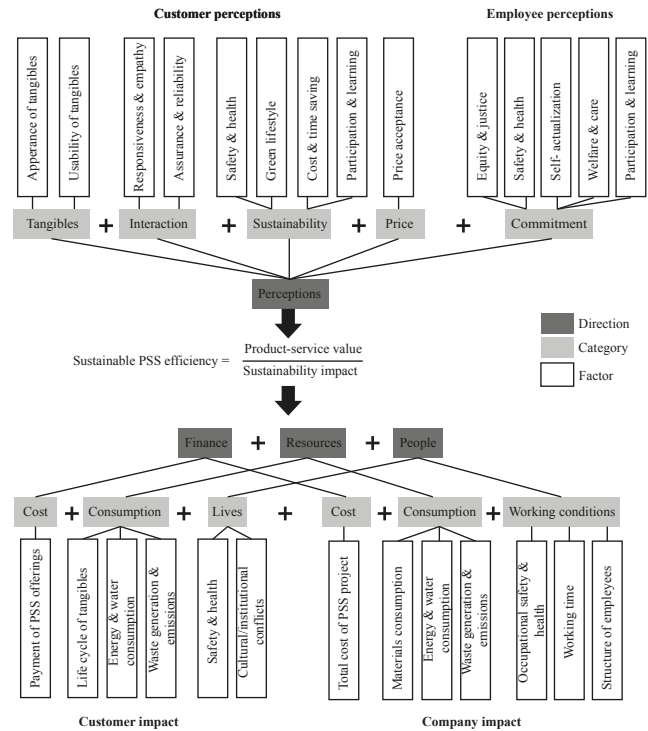


Fig. 3. SPSS hierarchy of multiple criteria (adapted from [7])

Service design tools may be used to analyse the consumer experience for each of these interaction types. Service design tools, and their use in the design of PSS are discussed in more detail in Section 3.2. In the case of the perceived sustainability of the product, the PSS is a strategic fit with the regional government sustainable procurement strategy. A new national framework agreement for office furniture procurement is being finalized and is due for launch in January 2015. The focal company has been instrumental in securing the presence of remanufactured furniture in the framework agreement. The focal company also has a long-standing policy of local sourcing and manufacturing which satisfies other regional government procurement criteria and this increases the likelihood that they will remain recommended suppliers for regional government. The focal company's presence as a recommended supplier contributes to the customer perception of sustainability. Other sources of information which can contribute to this are corporate social responsibility (CSR) communications containing information about the relationship with the ECO-WISE. Price acceptance can be evidenced through customer willingness to enter into the PSS and any increase in customer loyalty resulting from an increased positive perception of the PSS will be evident from repeat purchases.

Information on employee perceptions of the PSS and their consequent commitment to it may be gathered within the

service design process. This is discussed in more detail in Section 3.2.

It is relatively straightforward to measure the customer and company impacts using standard approaches. As this is the focal company’s first exploration of the remanufacturing/refurbishment market, income generated from the uptake of the PSS by the public sector provides the relevant cost data. The cost of PSS development and implementation can also be calculated from the company’s financial records.

Consumption criteria contributing to customer and company impact are addressed by the outcomes of the LCA scenarios. These provide guidance on how long the chair should remain in service to gain maximum benefit, which should be reflected in the PSS design.

Compliance with health and safety standards for products and processes can ensure that the product does not impact on the health and safety of the consumer and the people involved in the PSS. Assessment metrics can take into account health and safety accident logbooks, hazardous materials data, products returned due to failure and working hour’s records. Combination of these criteria, as shown in Figure 3, can provide an indicator of the sustainable PSS efficiency.

3.2 Extending service design tools for optimizing social factors in sustainable PSS

Activity	Research phase		Insights, Opportunities & Ideation phase		Design & Development phase	
External service designer experts	Identify key stakeholders of the study. Understand stakeholders perception of: the tangibles, interaction with service offer, sustainability and price by conducting: • interviews • observation	Build personas for each stakeholder Create ‘journeys’ for PSS showing the touchpoints Review of similar and competitor services	Prepare workshop activity with focal company on: • presenting insights, opportunities; feasibility and ideas from the study • additional technical information Prepare ideation workshop materials	Write PSS model aims and design brief Create draft service blueprints for new PSS Present to focal company: • service blueprints • PSS aim and design	Design service prototype and set up user-testing Invite focal company to user testing Create final service blueprint and user journey Create final service touchpoint visuals	Write new roles and responsibilities for focal company employees involved in PSS Write PSS feasibility and viability report Design brief and service specification document
Focal Company	Meet with external service design team and identify the key stakeholders for PSS Support stakeholders contact		Attend workshop	Attend meeting Select the final PSS model	Attend user-testing sessions and final service prototyping Produce economic, social and environmental projections for final PSS	Pitch final PSS to senior management with external service designer experts
Outputs	Key stakeholders identified Understand stakeholders perceptions	Personas developed for each stakeholder Stakeholder ‘journeys’	Insights & opportunities report Workshop materials New PSS models	Design brief document New service blueprints Final PSS model	Service prototype Final service blueprint	Product-service system feasibility and viability report Design brief and service specification document

Fig. 4. Service design methods.

The focal company has engaged external service design experts to support development of the PSS. Traditionally service design tools are used to improve customer satisfaction, and rarely take into account the value the customer may derive from addressing sustainability issues [7]. However, they may easily be adapted to establish the customer’s perceptions of environmental and social value, and the relative importance they place on these factors. Figure 4 shows the method initially proposed by the external service design team that, as we now discuss, may be augmented to ensure that environmental and social aspects of the PSS are taken into account in the design stage.

In the research phase, the service design experts propose to undertake interviews with the pilot study customers. This would normally involve establishing the customer’s perceptions of the product, price and interactions with the focal company and its employees. It is straightforward to extend these interviews to gain information on the customer’s sustainability perception criteria. Discussing the two PSS alternatives within the interviews with stakeholders can provide information on dealer and market perception of the use-oriented PSS and address the focal company’s concerns.

Ethnography and shadowing are important tools for service design. These are usually conducted in order to gain an insight into how the company interacts with the customer. However, they also provide a useful platform for determining employee perceptions of the PSS. In this context, the term ‘employees’ extends beyond the focal company to cover all those stakeholders involved in the PSS. As such, observational research should be undertaken with the focal company’s sales and service team, dealers and ECO-WISE. These should be augmented with interviews gauging the perceptions of the different employee categories.

Throughout the interviews, care must be taken to allow the participants to expand on the different criteria; they are broad and there may be differences in each stakeholder interpretation.

The findings of the interviews and observations can be used to produce detailed personas of all stakeholders within the PSS. The personas developed should include economic, environmental and social perceptions. The personas can either be described qualitatively or semi-quantitatively; estimated rankings can be placed on the relative importance of the different perceptions of each group. The personas are a rich source of information for the focal company and the aid in visualization of stakeholder ‘journeys’ through the service. Journey mapping is used to improve the customer experience

by identifying how they interact with the service and which areas should be the focus for improvement. Extending these to provide a clear representation of each stakeholder's experience will provide a series of points for improvement to be taken into the next phase of the service design. The different journeys can be compared to determine how a proposed improvement may impact on another stakeholder's experience.

Armed with this information, the focal company is in an ideal position to make the most of the ideation phase of the service design. While best practice may suggest that all stakeholder groups are involved in the ideation process, in practice this can be challenging to organize and facilitate. The personas and journeys provide a compromise; they encourage the focal company to view the PSS for different stakeholder viewpoints. The purpose of the ideation phase is to develop different PSS combinations. In the initial brainstorming, no ideas should be dismissed; however, an evaluation process should follow this and it is important that the focal company review and agree the key intentions of the PSS from their perspective; any service combinations which do not maximize these intentions should be put to one side.

It is likely that several different PSS scenarios will result from the ideation phase and be taken into the design and development phase. A service blueprint is often used at this point. A blueprint should provide enough detail to verify that the service meets the focal company's aims and that it can reasonably be implemented. In the case of a sustainable PSS, it is at this stage that the relevant quantitative information on social, environmental and economic impacts of implementing the service should be included. These may be weighted towards the company's key priorities. In the case of this PSS, the company's key aim is a reduction in resource intensity; the abridged LCAs of the different PSS scenarios may be compared and used to rank them initially. This could potentially provide information on the difference in environmental benefit of the product-oriented and use-oriented PSS models, always supposing that use-oriented PSS ideas have survived the evaluation phase. Once the environmental benefit of the PSS has been established, the focal company can identify any significant differences in projected service costs, marketability and social wellbeing between the scenarios and select the final PSS, which can then be prototyped with stakeholder representatives.

4. Conclusions

The pilot take-back scheme undertaken by the focal company has underlined some of the challenges of working with the ECO-WISE organization, and must be considered in the subsequent development of the PSS. Careful service design is essential and the standard tools can be augmented to take into account relevant social factors and combined with standard economic and environmental measures to support

development of a sustainable PSS. Within sustainable PSS development, there are likely to be trade-offs between environmental, economic and social criteria. Bringing together the academic areas of service design and ecodesign, it is possible to develop a blueprint that incorporates robust data on impacts, as well as more qualitative information on perceptions that can allow companies to determine the overall feasibility of a PSS.

This paper contributes to the academic understanding of PSS by providing evidence of the typical challenges a company faces when planning PSS and suggesting tools that can be used in the planning process. It should be noted that the focal company has a strong record in sustainable design initiatives and first began discussing PSS implementation almost a decade ago. However, real world examples of sustainable PSS that can be used to inform development are few and far between. Articulating the early stage process of the focal company can support others who are interested in tackling similar issues.

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