GCSM
11th Global Conference on Sustainable Manufacturing
2013
23rd - 25th September
Berlin - Germany

17.6 Openness as a supportive paradigm for eco-efficient Product-Service Systems

J. Bonvoisin[1], J. Wewior[1], F. Ng[2], G. Seliger[1]

[1] Department for Machine Tools and Factory Management, Technische Universität Berlin, Germany

[2] J C Bamford Excavators Limited, Lakeside Works, Rocester, Staffordshire, ST14 5JP, United Kingdom

Abstract

Product-Service System (PSS) is a concept which can be exploited to increase the eco-efficiency of value creation. It does not focus only on physical products but also on common access to their functionality, thus allowing mutualizing of products between manufacturers and users. However, reaching PSS eco-efficiency requires facing the challenge of an intensive information exchange between them. Especially in the case of business-to-consumer offers, stakeholders are an anonymous crowd of users, of which product usage information is hard to be obtained. This paper explores the potential of the Open Design concept - the opening of the development process and its documents - in order to address this problem. By promoting user involvement, Open Design might bridge the gap between use-related information and the design process – thus supporting eco-efficient PSS design. This general idea will be illustrated by the examples of PSS taken from both business-to-business and business-to-consumer domains.

Keywords:

Open Design; Product-Service Systems (PSS); eco-efficiency.

1 INTRODUCTION

It is an often quoted challenge that the eco-efficiency of products shall be increased by more than a factor of ten in order to reconcile economic development with the conservation of the natural capital. To face this challenge, significant efforts have been made by engineering scientific communities within the development of ecodesign, i.e. methods to introduce the environmental dimension into product design (e.g. [1-2]). However, despite of the promising progress these methods were addressing, it still remains unlikely that eco-efficiency of products and services can be increased by a factor of ten. Focusing on products and processes remains limited if consumption patterns remain disregarded at the same time [3].

The focus on the consumption patterns in engineering sciences can be achieved by addressing business models, i.e. how value is created by the interaction of value creation factors (products, processes, organisation, utilities and organisation). In recent years, a wave of innovative business models brought two concepts with interesting potentials for sustainable value creation: Product-Service Systems (PSS) and Open Design.

This paper aims to underline the common advantages of these two concepts and their potential synergies. Furthermore, it studies how Open Design can be used to support the operation of eco-efficient Product-Service Systems, with the help of two concrete examples from the field.

In section two, we highlighted the respective potential advantages of both concepts for sustainable value creation as well as their similarities. In section three, we explored the potential contribution to Open Design for eco-efficient Product-Service Systems before concluding on our reflections in section four.

2 INNOVATIVE BUSINESS MODELS

In this section, we highlighted the potentials of Open Design and Product-Service Systems for sustainability, identify their similarities and define their possible synergies.

2.1 Product-Service Systems

In the past decades, an increasing number of companies shifted their focus from product to customer satisfaction, thus opening opportunities in the offering of innovative solutions to satisfy customer needs. This shift in focus promotes the idea that customer cannot be fully satisfied through merely the purchase of goods, but rather by providing access to better functionalities and services.

Business models implementing this shift can be classified under the name of Product-Service Systems (PSS) – a phrase that describes an integrated offer of products and services aiming at customer satisfaction. By renouncing to focus exclusively on the product, PSS gives the potential to fulfil customer's needs in an innovative manner, to decrease resource consumption, to intensify the relationship between providers and customers, and thus to offer services that better fit the customer's demands.

More than describing a unique reality, this umbrella-concept covers a high diversity of business models. Tukker [4], for example, distinguishes eight types of PSS according to the intensity of the relationship between customers and providers and to the respective part of the value-added offered through products and services (table 1). Based on this, he named three categories of PSS depending on what is on the focus of the commercial exchange: the product-itself, its use or the result it provides.

As PSS opens opportunities for innovative solutions to satisfy customer's needs, it has been argued that PSS has a

G. Seliger (Ed.), Proceedings of the 11th Global Conference on Sustainable Manufacturing - Innovative Solutions
ISBN 978-3-7983-2609-5 © Universitätsverlag der TU Berlin 2013

potential for conciliating economic value creation and preservation of the environment, thus addressing the ecological dimension of sustainability. Therefore, many proposed definitions of PSS include clear references to the environment, such as this often-cited one: "product(s) and service(s) combined in a system to deliver required user functionality in a way that reduces the impact on the environment" [5]. However, several authors call for a better systematic study of the environmental friendliness of PSS, stating that they are not automatically eco-efficient (e.g. [5-6]), notably due to the fact that the term PSS covers a broad range of business models. Nonetheless, it is already widely accepted that PSS show several interesting environmental potentials - especially the use and result oriented ones, as presented hereafter.

Use-oriented models like product sharing may have the following advantages [3, 7]:

- Long product service time, through the design, production and use of reliable and long-lasting products and through maintenance and upgrade;
- Extended producer responsibility, encouraging the take back of products, reuse, remanufacturing, recycling;
- Reduced number of products required to fulfil customers' needs.

Result-oriented services, through internalization of all product-related costs (including use), may have the following advantages [3, 6, 8]:

- Natural incentive to reduce total lifecycle costs, including environmental impacts, operating a natural selection of the most efficient solutions;
- Professional use of products, ensuring lower energy consumption and better care.

Product-oriented services	Product-related service
	Advice and consultancy
Use-oriented services	Product lease
	Product renting or sharing
	Product pooling
Result-oriented services	Activity management/outsourcing
	Pay per service unit
	Functional result

Table 1 - The eight types of PSS according to Tukker from value mainly in product content at the top down to value mainly in service content [4].

2.2 Open Design

The concept of Open Design derives from the extension of the open source movement – originating from software development – to the design of physical products. It refers to "the openness of all accompanying documents in a product development processes, with the aim of collaborative development of tangible objects" [9]. This implies on the one hand that product definition is considered as a common and follows the four principles of the open software philosophy (right to see, use, modify and redistribute). Yet, the design process is no longer considered as the activity of a defined team agreed on confidentiality, but is on the contrary open for the participation of an undefined crowd of interested people. As a consequence, product development cannot be seen any more as a defined project with clearly defined inputs, outputs and timeline, but rather as an on-going process of continuous improvement by a *community* of interested people.

Open Design (as well as open software) can be considered as "an innovative form of production based on a new conception of copyright, a decentralized organization of work, voluntary work and user involvement" [10]. The potential advantages of Open Design are the following [11, 12]:

- Better quality of designs due to higher number of peer reviews;
- Reduced R&D costs and development time due to the involvement of a higher number of (voluntary) contributors;
- Faster innovation and adoption of the latest technologies.

Like PSS, the concept of Open Design is more of a composite figure characterising different concrete situations than a solid representation of a unique reality. The term Open Design can apply to a wide range of design processes and some of these processes are still currently being invented as Open Design is a relatively new concept. Examples of these are "Living Labs", e.g. the physical meeting of several actors of the same product lifecycle in order to identify improvement potentials. Another example would be the publication of product definition documents by their original equipment manufacturers (OEMs) on the internet in order to motivate spontaneous improvement propositions from any interested contributor.

Beyond this diversity, there are two fundamental rules for Open Design: do-it-yourself and mutualisation of knowledge. Open Design promotes the independence of the users to the technology, in reaction to the passivity of the consumer behaviour in mass production. It also promotes reciprocity and mutual learning, giving a progressive meaning to this movement [10]. Under this viewpoint, Open Design questions the relationship between people and factors of production and can be viewed as a potential contribution to the social dimension of sustainable value creation.

2.3 Similarities between the concepts

Beside their respective complementary potential contributions to sustainability (illustrated by figure 1), PSS and Open Design business models show several striking similarities:

- Both take part in a general trend to shift from mass production to mass customization, which tends to consider consumers less as passive buyers with predefined standard needs than as demanding customers with specific requirements.
- Both of them propose a redistribution of the roles between stakeholders in value creation: providers and customers are involved in a process of co-creation where the consumer becomes a "prosumer" and the provider's role is more to propose value than to propose products.
- Both tend to redefine the timeframes of product lifecycles. In PSS business models, the economic exchange is no longer a punctual meeting of self-serving actors on a market, but a long term relationship. In Open Design, product development is less project-oriented (with focus on precise results, starting and ending dates) than process-oriented (with focus on a precise activity).
- Both propose a redefinition of the concept of ownership. Many of the PSS business models provide products for free. In Open Design, it is the product information that is free (which does not imply that the product is also for free).

- For the two of them, this can be either considered as a "commercial suicide" [12] or the opportunity to move to more innovative business models and to differentiate from the competition.

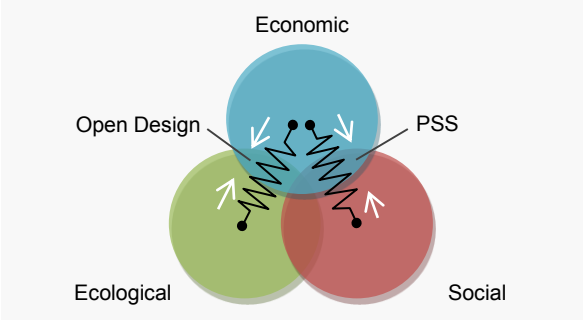

Figure 1 – Complementary contributions of PSS and Open Design to the dimensions of sustainability.

With respect to these similarities and complementarities, it could be insightful to study the potential synergies that exist between these two concepts. For example:

- Development of product-oriented business-models (e.g. advice, consultancy) on the basis of an open design product;
- Manufacturing of open design products in service-oriented business models like MAAS (Manufacturing As A Service) [13] or professionalized FabLabs [14];
- Deeper integration of the customer in the co-creation process of PSS through its participation in design.

3 OPEN DESIGN AS A SUPPORT FOR PSS

In this section, we attempt to study the possible contribution of Open Design as a supportive paradigm for Product-Service Systems. We start to identify challenges appearing in the concept of PSS. We then present two case studies from both the B2B and B2C domains that illustrate these challenges. For each of them, we propose a possible implementation of Open Design solutions.

3.1 Two challenges: understanding and motivating

Shifting to PSS still remains a challenge. Especially for use and result oriented PSS, this implies a strong cultural change on both customer and provider sides [5]. The customer has to renounce on the ownership of the product. The provider has to accept to let the user in taking a larger role in value creation. At the end, both parties should agree on a co-production process, rather than a punctual property exchange.

Particularly on the provider's perspective, this relationship of co-creation brings additional uncertainty into the business model [15]. Additionally, it should be considered that customers are not only interested in the use of products but also on their ownership, which reflects social status and self-esteem [16]. Therefore, customer behaviour may be motivated by other criteria than rationality and eco-efficiency. This fact is representing a threat for the objective of eco-efficiency of PSS.

Consequently, customer behaviour has a critical influence on both the environmental and the economic performance of PSS [16]. This raises the following two challenges of the design and operation of PSS:

- Understanding the user behaviour in order to design efficiently both tangible (e.g. products) and intangible (e.g. maintenance service) elements of the PSS;
- Encouraging the users to efficiently operate the usage phase of tangible elements.

These challenges have already been highlighted by Mont and Plepys [16], particularly for the B2C domain, who pledged for a better understanding of the customer satisfaction in PSS business models through the use of tools close from user centred design like surveys, focus groups or observation. Despite the indisputable contribution to these methods, they remain difficult to operate in daily practice. Customer surveys, for example, are good opportunities to make suggestions on both products and services, but are still not common practice across the industry [17].

At the same time, Open Design provides an opportunity to create a sense of ownership and belonging through the involvement in the design process. On one side, one can develop a sense of ownership through the participation in the birth of a product. On the other side, through this participation, one can get the feeling of belonging to a community. "This product is mine, not in the sense that I own it, but because I participated in its creation. I am also part of a community of the people that participated in this creation".

In the following sections, we present two examples of PSS illustrating both the challenges of motivating and understanding the customer. For each of them, we present a potential answer based use of Open Design. The first example is taken from the B2C domain. It illustrates the need to motivate the user for a more careful use of the product in order to reduce downtimes. The second example is taken from the B2B domain. It illustrates the need of getting use-related information to improve maintenance.

3.2 B2C domain – Rent a bike service

Métrovélo is a rent-a-bike service offered by the city of Grenoble, France. It is delivered by a shared public/private organisation that maintains since 2004 an ever growing pool of more than 3500 bikes that can be rented for a duration spanning from one day to one year. The service encounters an interesting success: since its beginning, more than three millions of renting days have been registered, meaning that the well recognizable yellow bikes are now a part of the local culture (figure 2).

Métrovélo PSS offers

This service belongs to the use-oriented PSS class of Tukker's [4] classification: the product is still in the focus of the commercial exchange, but there is no exchange of ownership (the user does not own the product after the commercial exchange). More precisely, this is a pay-per-access service (in opposition to pay-per-use): users pay for a certain time of access to the product, whatever may be the number of kilometre they ride.

Métrovélo provides three different offers:

- Renting from agencies: the activities of picking the bike up and giving it back are performed in an agency with the help of an employee. The duration of rental contracts can span from 1 day to 1 year. This offer represents the highest share of the activity of the organisation.
- Automatic renting: the activities of picking the bike up and giving it back are performed through an automatic rental system. The rental fee is accounted on an hourly basis.

- Bike pool renting: Métrovélo provides dedicated bike pools for companies who want to offer their employees the possibility to use bikes in their daily trips.

Each of these offers includes the maintenance of the bikes: in case of failure, each customer can come to a Métrovélo agency to have his bike fixed. If a repair cannot be made within a reasonable time frame, the customer is provided with a functional bike waiting in the stock.

Figure 2 - The easy recognizable yellow "Métrovélo" – (Credits: SEMITAG - P. Paillard).

On the relevance of use behaviour

Thanks to the provision of three different servicing conditions, Métrovélo understands the level of motivation customers have in taking care of the product would influence the maintenance requirements (in its frequency and the seriousness of the performed repairs). This experience allows deriving the main influencing factors of the customer behaviour:

- The length of the rental, that allows the establishment of a psychological relationship between the user and the product (feeling of ownership), and let the user be more experienced with the use of his bike (as a consequence, the ratio between the time the product is used by an inexperienced person and the time it is used by an experienced person is reduced).
- The existence of a direct face-to-face relationship between the renter and the user, which tends to reinforce the customers' feeling of responsibility.

These factors are illustrated by the intensity of the maintenance for the three different services offered by the organisation:

- Renting in an agency. In this most favourable case, most bikes are rented for a long period of time (e.g. 3 months or one year) and a direct face-to-face relationship is led between the renter and the customer. In this case, downtime rates are low.
- Bike pool renting. In this less favourable case, the customer is not the user, meaning that there is no direct contact between the owner of the bike and the user. Moreover, bikes are solely taken out of the pool for short trips. Downtime rates in this case are higher than in renting from agencies.
- Automatic renting. In this least favourable case, there is no contact between the user and the renter, and bikes are rented for short trips. Currently, Métrovélo is unsure on the customers' behaviours for this service, especially as additional preventive maintenance is performed on these bikes. Other organisations delivering automatic renting of bikes however witness of significantly high downtimes rates due to misuse (as illustrated for example by Amaya et al. [18]).

Scenario of Openness

Bikes are relatively simple and mature products beneficiating mankind for more than a century. In the case of bike renting, bikes are designed to be robust and not particularly high tech. Consequently, these products can be easily reverse-engineered and intellectual property is not a crucial element within the business model. Therefore, giving access to product definition documents does not represent a threat to the organization.

The product design could be held available for consultation and modification on an Open Design platform, where users could propose design improvements. Firstly, this could help benefit from a continuous improvement of the product design at a lower cost. Secondly, this could help reinforcing the idea of a community of users, and give more affective value to the yellow bikes. Thirdly, this could provide an opportunity to offer new services like customization. Customers can design customized add-ons on the platform. These add-ons could be produced by the service-provider and disseminated through a social network-like feature of the platform. Finally, this could promote qualification of customers and offer them the opportunity to be active also on the maintenance, thus extending the do-it-yourself logic from design to maintenance. Beyond these benefits, the challenge is to make users feel responsible for products they do not own. Especially, products being used for short durations may be handled with low care, and therefore may have a lower environmental performance. Letting users to voice their needs directly in design stage can create a feeling of ownership promoting a sense of responsibility towards the use of products.

The presented solution may however raise several new questions, e.g.:

- To what extent would the users participate in the open design platform?
- How to set up a platform that can manage the contribution of several anonym contributors to the product definition (like an open version of product lifecycle management)?
- How to manage the diversity of products generated by the continuous improvement and the customization in a service where the maintenance efficiency is based on the homogeneity of products?

3.3 B2B domain – Machinery industry

J C Bamford Excavators Ltd (JCB) is one of the world's top three construction equipment manufacturers. JCB produces a variety of over 300 machines sold into construction, agriculture, waste and recycling as well as power generation industries. It was founded by Joseph Cyril Bamford in 1945 in Uttoxeter, Staffordshire, UK. Since then, JCB has expanded to 22 factories on 4 continents and has over 750 dealers worldwide. In May 2013, JCB marked the production of the company's one millionth machine, with nearly one out of every two backhoe loaders sold today being a JCB.

JCB PSS offers

As a manufacturer, JCB also provides the support for spare parts and services to their dealers to care for their customer's machines [17]. The service offered to dealers by JCB belongs to the product-oriented PSS class of Tukker's classification.

On board telemetric data collects use-phase information to generate the requirement of services during or at the end of operational periods. Based on the level of usage, JCB will coordinate with their dealer's service technicians and provide necessary information, service parts or technical support.

JCB offers different service packages to the dealers at the point of sale to suit different dealer's targeted markets.

- Service Agreement: The flexibility for customers to set up a service agreement at the time of purchase, allows the planning and managing of the machine maintenance budget. Service intervals can be based on engine hours / fixed time.
- JCB Premier Cover: 5 Years maximum period or 10,000 engine hours of cover from the date of purchase. Repair and replace defective components in the machine. Machines are also regularly serviced by approved JCB dealers.
- Full repair and Maintenance: Regular maintenance and repairs conducted by JCB dealers with a fixed sum per month. Covers machines up to 5 years or 10,000 engine hours usage.

The effectiveness of these service packages heavily relies on the amount of accurate use-related information being collected and used to determine the needs and requirements at the service intervals.

Figure 3 - Typical Service Support (Credits: JCB).

On the relevance of use-related information

Gaining precise use-related information helps defining realistic use scenarios that can in turn support the definition of reliable preventive maintenance programs. At the end, it helps to reduce downtime and the severity of the problems occurring on machines. This information could also be used for further product improvement. It is, however, difficult to get precise and relevant information on the level of usage. Three sources are currently being used: getting information from the machine (telematics), servicing (investigation during maintenance), or the customer/user (questionnaire).

Telematics. The machines are equipped with sensors and electronics that record activities of the machines (e.g. pressure and proximity switches). This information can then be collected during maintenance.

These systems can be costly but justified to reduce machine downtime: the end of life of components can be accurately predicted and a replacement of such components can be scheduled in before failures materialised.

Due to current technological limitations and the availability of space on machines, captured information is likely to be insufficient to generate a full picture of the machine usage. Furthermore, some construction machines are designed to perform various numbers of different jobs/duties (>25), as a result, identifying these duties using sensors will require sophisticated algorithms.

The advantage of telematics is thus limited, and more technical solutions may be required.

Diagnostic during maintenance. When searching for the root cause of a technical problem, assumptions tend to be made. It can be difficult to make an accurate diagnosis without a full picture in how the machine has been used. Generally, service technicians take the forensic approach by searching for symptoms, such as slow service speeds and internal hydraulic leakage.

Consulting with the customers. Direct communication with the customers is considered the easiest way to gather important evidence. Yet the process can be time consuming, and customers may not always tell the truth. Furthermore, customers may not be the end-user, who will not be able to provide any useful information but inaccurate personal assumptions/evaluations.

Scenario of Openness

On this example, product design and technical innovation is a key factor within the business model of the company. Giving access to the product definition thus implies non negligible risks. To avoid this pitfall and to benefit from the users' experience, a softer version of Open Design could be used, like a Living-Lab approach: a meeting of actors of the product lifecycle that try to generate ideas for product improvement. OEMs could set up global exchange conferences, where dealers, customers and end-users were invited to contribute with their personal experiences and suggestions to the design and development of new and current products. Discussion groups can be divided by a particular machine type, and chair by an engineer of the particular specialty. Such events would promote discussions based on the actual needs and requirements from the customers/end users, breaching the barriers of between all parties.

Another solution is to let the users formulating ideas directly from the place they may appear, i.e. the workplace. On-board solutions could be used for this purpose – e.g. embedded computer with touchscreen (to make quick drawings) and a voice recorder (to express ideas directly as they appear).

These solutions may however raise several questions, e.g.:

- To what extent would be the users ready to participate and express their ideas/comments?
- How to design an ergonomic on-board solution helping the user expressing ideas in a form that is usable by product designers?
- How to design a system for on-board solution that would be accepted by users and freely used?

4 CONCLUSION & OUTLOOK

In this paper, we made the first attempt to identify potential synergies between PSS and Open Design ways of thinking. The arguments in this paper suggested that both concepts

are following a common trend, sharing many characteristics and can bring complementary answers for the design of sustainable business models.

However, associating these two complicated concepts may raise more questions than providing answers. For example, it seems that this association is more relevant (or at least easier to implement) for the B2C domain than for the B2B domain (because in this last case, the user and the contractor are not the same person). Some aspects of the two concepts may also seem contradictory: how to conciliate the trend of systematic outsourcing proposed by the PSS logic with the also systematic do-it-yourself thinking proposed by the Open Design logic? Is a deeper integration of the actors of the product lifecycle and an ever decentralised design compatible?

The aim of this paper is therefore not to derive new concepts and nor to participate in the explosion of fragile and inapplicable concepts, but, to identify common characteristics that can give ideas for sustainable product and service offers. The first theoretical reflections presented here shall be followed by implementations and critical analysis of concrete examples, that we hope these first reflections will motivate. (Open) work in progress…

5 ACKNOWLEDGMENTS

The authors would like to thank Alain Montillier (Métrovélo) and Jörg Wimalasena for their precious contributions in this paper.

6 REFERENCES

[1] Abele, E., Reiner, A., Birkhofer, A., 2004, *Environmentally-Friendly Product Development: Methods and Tools*, Springer.

[2] Brissaud, D., Tichkiewitch, S., Zwolinski, P., 2006, *Innovation in Life Cycle Engineering and Sustainable Development*, Springer.

[3] Meijkamp, R., 1998, Changing consumer behaviour through eco-efficient services: an empirical study of car sharing in the Netherlands, *Business Strategy and the Environment*, 7/4:234-244.

[4] Tukker, A., 2004, Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet, *Business Strategy and the Environment*, 13/4: 246-260.

[5] Baines, T. S., Lightfoot, H. W., Evans, S., et al., 2007, State-of-the-art in product-service systems, *Proceedings of the Institution of Mechanical Engineers: Part B Journal of Engineering Manufacture*, 221/10:1543-1552.

[6] Lingegard, S., Sakao, T., Lindahl, M., 2012, Integrated Product Service Engineering - Factors Influencing Environmental Performance, *Systems Engineering - Practice and Theory*, Cogan B. (ed.), InTech.

[7] Intlekofer, K., Bras, B., Ferguson, M., 2010, Energy Implications of Product Leasing, *Environmental Science and Technology,* 44/12:4409-4415.

[8] Pigosso, D., Is the Industrial Product-Service System really sustainable? 2010, presented at the 2nd CIRP IPS² Conference, Linköping, Sweden.

[9] Geyer, M., Reise, C., Manav, F., *et al.*, Open design for manufacturing – Best practice and future challenges 2013, presented at the 10th Global Conference on Sustainable Manufacturing (GCSM 2012).

[10] Depoorter, G., 2013, La "communauté du logiciel libre" : espace contemporain de reconfiguration des luttes? in *Résister Au Quotidien ?* Frère, B., Jacquemain, M. (eds.), Presses de Sciences Po, Paris.

[11] Buitenhuis, A. J., Pearce, J. M., 2012, Open-source development of solar photovoltaic technology, *Energy for Sustainable Development*, 16/3:379-388.

[12] Howard, T. J., Achiche, S., Özkil, A., McAloone, T. C., 2012, Open Design and Crowdsourcing: maturity, methodology and business models, in *Proceedings of the 12th International Design Conference DESIGN 2012*, 181-190.

[13] Yip, A.L.K., Jagadeesan, A.P., Corney, J.R., et al., 2011, A Front-End System to Support Cloud-Based Manufacturing of Customized Products, in: Harrison, D.K., Wood, B.M., Evans, D. (Eds.), *Advances in Manufacturing Technology XXV - Proceedings of the 9th International Conference on Manufacturing Research ICMR 2011*, 193–198.

[14] Gershenfeld, N.A., 2007. *Fab: the coming revolution on your desktop--from personal computers to personal fabrication*. Basic Books, New York.

[15] Seiringer, W., 2013, A Rating for Customer Participation during the Process of Service Co-creation, in *Product-Service Integration for Sustainable Solutions*, H. Meier (ed.), Springer, 647-658.

[16] Mont, O., Plepys, A., 2003, *Customer satisfaction: review of literature and application to the product-service systems - Final report to the Society for Non-Traditional Technology, Japan*.

[17] Ng, F., Harding, J., Rosamond, E., 2013, A Customers' Satisfaction Based Framework for Continuous Development of PSS, in *The Philosopher's Stone for Sustainability*, Shimomura, Y., Kimita, K. (eds.), Springer, 239-244.

[18] Amaya, J., Lelah, A., Zwolinski, P., 2013, Environmental Benefits of PSS Strategies: A Bicycle Sharing System Case Study," in *The Philosopher's Stone for Sustainability*, Shimomura, Y., Kimita, K. (eds.), Springer, 339-344.