



Product Services Systems and Value Creation. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems

Literature study on factors influencing the market acceptance of PSS

Sebastian A. Schenkl*, Christian Rösch, Markus Mörtl

Technische Universität München, Institute of Product Development, Boltzmannstraße 15, 85748 Garching, Germany

* Corresponding author. Tel.: +49-89-289-15138; fax: +49-89-289-15144. E-mail address: sebastian.schenkl@tum.de

Abstract

Product-Service Systems (PSS) as an integration of product and service elements in one market offer promise amongst others better fulfillment of customer demand, quicker innovation, differentiation from competitors and sustainability. However in the industrial practice there are major challenges in successfully offering these PSS. One of these challenges is to gain market acceptance for PSS. Whereas benefits for providers and customers have been widely discussed in literature, going beyond these statements and analyzing factors on the market acceptance of PSS is hardly discussed. The paper gives the theoretical foundations for a model explaining an integrated set of factors for and against the market acceptance of PSS in B2B environments.

© 2014 Elsevier B.V. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Selection and peer-review under responsibility of the International Scientific Committee of “The 6th CIRP Conference on Industrial Product-Service Systems” in the person of the Conference Chair Professor Hoda ElMaraghy”

Keywords: product-service systems, customer acceptance, market acceptance

1. Introduction

Product-Service Systems (PSS) integrate product and service elements in one market offer [1]. Tukker [2] distinguishes three main types of PSS: 1) Product oriented PSS incorporate product related services such as maintenance as well as advice and consultancy. 2) Use oriented services that rely on alternative business models such as renting, sharing, and pooling instead of selling a product to the customer. 3) Result oriented PSS incorporate activity management, pay per service unit and functional result. The benefits of PSS, have been widely discussed in the literature (see section 2.2f.). Besides that, there is very little consideration for the market acceptance of PSS. The term acceptance depends on three components: attitude (formed by evaluating benefits and drawbacks, e. g. of a PSS offer), action (as the application of an attitude, e. g. in contracting a PSS) and usage [3]. A general theory of the diffusion of innovations is given by Rogers [4]. He describes five factors influencing the adoption of product innovations: relative advantage, compatibility, trialability, observability,

complexity. These characteristics have been adapted for analyzing acceptance of consumer market PSS [5]. Also other authors focused mainly on consumer market [5-8]. A striking prediction for customer acceptance of PSS is given by Manzini and Vezzoli [9]: “A major element of a PSS is that a client (...) demand is met by selling satisfaction instead of providing a product. (...) If the satisfaction is evident, then customers would see a PSS as a preferable choice”. However some authors admit a lack of market acceptance of PSS for both business-to-consumer (B2C) [6] and business-to-business (B2B) markets [10, 11]. Understanding of customer behavior in the context of PSS is “underresearched” [11]. PSS promise manifold benefits to customer, but describing these benefits seems not to be sufficient for explaining the market acceptance. Further factors must be considered.

This paper introduces factors influencing the market acceptance of PSS in B2B markets. Therefore we have carried out an extensive literature study for identifying these factors in publications on PSS. Since that issue is hardly discussed in literature we have expanded the focus and also adjacent and overlapping research topics such as outsourcing and

performance based contracting were considered. Thereby we studied typical customer behavior and extracted motives for accepting or rejecting these market offers. The underlying assumption is that a fundamental understanding of the recommendations in literature regarding these topics allows for conclusions on the market acceptance of PSS. The underlying research question is: Which factors have a positive or negative influence of the customer acceptance of PSS in B2B-markets? On discussing the customers' action strategies, we frame the theoretical foundations for an integrated model for decision making whether PSS are a suitable market offer for a specific company and if so how the characteristics of the offered PSS should be designed.

2. Market acceptance and benefits of PSS in B2B-markets

Firstly, we have conducted a literature review on market acceptance of PSS for B2B markets. Thereby literature on PSS, IPS², servitization and functional sales was considered. In total 31 publications were analyzed regarding factors influencing market acceptance as well as benefits of PSS for the B2B market. In this chapter the results are briefly discussed. Benefits were analyzed in order to get an understanding about promises of PSS, forming the attitude of potential customers towards a PSS offer. For getting towards an integrated understanding of influencing factors of market acceptance of PSS, we discuss benefits and limitations of PSS. Benefits for providers are regarded if these benefits are a win-win-situation or if they are got at the expense of the customer benefits and thus may impact on market acceptance.

2.1. Factors influencing market acceptance

Several authors admit the lack of customer acceptance of PSS in industrial practice (see section 1). Whereas the promised success of PSS is based on the assumption that customers want the benefits of a product and not to own it (cp. [9]), some authors see that this assumption is not always appropriate [12]. Other factors hindering the market acceptance are the loss of perceived control by the customer [13] and the access to sensitive information from the customer when the service providing personnel is entering his facilities [11]. Customers that have a lack of knowledge about the lifecycle costs may perceive a PSS offering as expensive compared to a product offering [11, 14].

2.2. Benefits for PSS customers

PSS are supposed to allow for enhancing the customer satisfaction. This is enabled by the better insight into customer needs [15] and a higher flexibility to fulfill changed customer needs [16]. The customer may benefit from the provider's expert knowledge [11, 17], for example for an optimized usage of the product [18] or participation of the engineering capabilities of the provider [17]. PSS allow for individualized offerings [15, 16, 19]. Outsourcing activities allow the customer for focusing on his core activities [2, 17]. Closely related to that, the user has less responsibility for the product [12, 16, 20]. Administrative or monitoring tasks are

transferred to the provider [20]. Another benefit is the sharing of risks regarding machine failure with the provider. The PSS thereby acts as an insurance [18].

2.3. Benefits for PSS providers

Benefits for providers relate to competition, company development, customer-relation, legal issues and finance. PSS allow for its providers for differentiating from the competition [10, 21-27] due to the integration of new knowledge and technologies as well as new concepts [23]. PSS may close the market for competitors selling spare parts and consumables [28]. Besides that PSS are harder to imitate than technical products [29-31]. Intangible services are hard to copy [17], for example due to the embedded knowledge that cannot be acquired by reengineering of a tangible product [28]. PSS allow for avoiding price-based competition because total cost of ownership is getting more important [32].

PSS allow for several benefits regarding the customer relationship. PSS locks the customer into a long-term relationship [30]. As it is formulated that has to be seen critically in the context of market acceptance of PSS because in reverse it implies that the long-term relationship is not in every case wanted by the customer. PSS promise a higher customer loyalty [2]. Besides that providing services of a PSS implies the benefit of a more direct customer contact [2, 30] since services are characterized by the uno-actu-principle [33]. This allows for getting a deeper insight into product usage and customer needs and thus for improving the market offer. PSS are a driver for innovation. PSS are better focused on the customer demand and thus allow for faster innovation [2] and the diffusion of innovations [29]. Legal requirements may foster the introduction of PSS [16]. New market opportunities are another aspect. Servitization extends the business model of manufacturing industries, also in mature, stagnating markets [11, 16, 29]. PSS are said to have benefits in a multitude of financial aspects: higher revenue, higher margins as well as more stable revenues, less dependent on economic cycles. Whereas the higher revenue bases on the broadened activities as well as the stability of revenues and is not further discussed in literature, the higher margins that are promised by some authors is discussed critically by Neely [34]. Neely made a study in servitized firms and identified that at least large firms have higher revenues but lower net profits. Small firms were able to realize the promised profits.

2.4. Benefits for society

The society profits both from PSS as a means for sustainability as well as the creation of new jobs. The most often stated benefit of PSS is their contribution to sustainability. That aspect is discussed in a multitude of facets (see for example [35-39]). PSS allow for decoupling economic growth and material input [10]. The provider has to consider the total cost of ownership. Thus the consumption during the product life cycle of resources and energy is getting more important [12] as well as a higher lifespan of the hardware may be economically favorable [35]. Remanufacturing [40] and upgrading [14] have a positive

impact on resource consumption. However PSS may be sustainably but are not by definition as Tukker and Tischner demonstrate [22]. Another societal benefit is the creation or at least preservation of jobs [18], due to the labor-intensity of services [10].

2.5. Conclusions

Whereas benefits of PSS have been widely discussed, there is only little consideration for influencing factors on market acceptance. Authors mainly focus on benefits for providers, customers and society. There is lack of a comprehensive set of factors that influence the market acceptance, going beyond promised benefits.

3. Research methodology

In the literature there is a lack of explanation of customer acceptance of PSS. Besides that PSS publications are written from the perspective of the PSS provider. The customer's opinion is underrepresented. To overcome that, we have analyzed literature from neighbored research fields in order to get artifacts related to market acceptance that can be transferred on the domain of PSS.

From these publications, we have extracted a comprehensive set of motivations for and barriers against outsourcing of activities (from a customer perspective). The following research fields were considered for: Operator models (industrial applications), Performance Based Contracting (PBC) and Outsourcing. Thereby we have assumed that the same or at least adequately similar correlations are valid for those PSS that also rely on outsourcing of activities. From a customer perspective these business models may be similar to PSS, since they rely on the same principle. To be specific this principle is the transfer of responsibility or activities (e. g. for operation, maintenance) from the customer to a provider, which is used by Finken et al. [41], Herzberger et al. [42] and Panshef et al. [43] for PSS development methods. The assumption is applicable for result oriented PSS. The special case of maintenance outsourcing correlates to a product oriented PSS, according to Tukker's definition [2].

A side effect of the approach is that the customer (instead of the provider) is in the focus of these publications and thus it is possible to understand the customer's behavior.

In total 18 references were concluded in the literature review. More than 120 text passages describing market acceptance of the analyzed topics were isolated. These text passages were classified if they have a positive, negative or varying influence. Afterwards the identified statements were aggregated into eight overarching factors. The results are discussed in the next section.

4. Motivation for or barriers against outsourcing

This section describes influencing factors for companies to foster or hinder outsourcing of activities. An overview of analyzed literature as well as the identified factors is given in Fig. 1.

| Reference | Factor | | | | | | | |
|------------------------------|-----------|----------------------|-------|--------------|----------------------------|--------------------------------|--|----------------------------------|
| | Financial | Risk and flexibility | Trust | Human factor | Technology and Performance | Knowledge lead of the provider | Knowledge transfer and access to knowledge | Core competencies and activities |
| Ford & Farmer [44] | x | | | | x | | x | x |
| Gómez [45] | x | x | | | x | | x | x |
| Srumpf [46] | x | x | | | x | | x | x |
| Siemer [47] | x | | | | x | x | x | |
| Hornschild et al. [48] | x | | | | | | x | |
| Lay & Schröter [49] | x | | | | x | | x | |
| Platts et al. [50] | x | x | | | x | | x | |
| Buck-Lew [51] | | x | | | | | x | |
| Garrel et al. [52] | x | x | x | x | x | | x | x |
| Hypko et al. [53] | x | x | x | | x | | | |
| Jauch & Wilson [54] | | | x | | | | | |
| Becker et al. [55] | | | x | | | | | |
| Campbell [56] | | | x | x | | | x | x |
| Bertolini et al. [57] | | | x | x | | | x | |
| Ng & Nudurupati [58] | | x | | | x | x | | |
| van de Water & van Peet [59] | x | | | x | | | x | |
| Kakabadse & Kakabadse [60] | | | | | | x | x | |
| Bustintza et al. [61] | | | | x | | | x | |

Fig. 1. Literature overview

4.1. Financial

An often stated motive for customers to decide to outsource activities is to save costs on a short as well as a long term perspective [44]. That cost advantage may be realized by the provider through better competencies in operating the machine [45] or economies of scale of the provider [46]. Furthermore the balance sheet total is reduced [47]. Another motive is transparency about total cost of ownership [46] as well as budget certainty [62]. Not buying a product but paying for its usage has the benefit of a lower need for investment [62], especially for companies that do not have the financial capability to invest in buying a machine [48]. PBC is also the preferable choice when the time period of the usage of a machine is shorter than its payback period [49].

4.2. Risk and flexibility

Closely related to financial factors is risk reduction. Financial risk reduction achieved by transferring fix costs into variable costs [45, 47]. Thus it is easier to cope with volume changes [50]. This means a higher flexibility for the customer [51]. Beyond these financial risks, also technical and organizational risks are transferred to the provider [52]. That risk transfer facilitates to bring new, unknown technologies into the market. When the customer does not have a deep knowledge about operation and maintenance as well as benefits of a product, he may be willingly to outsource the risks [53].

4.3. Trust

A benefit of outsourcing is long-term relationships with the customer. In a reverse conclusion, the customer has to accept a higher dependency from the provider [54]. For accepting that lock-in, the customer has to trust into capabilities of the provider. The customer needs to trust the quality and reliability of the provider [47, 52, 53, 55]. Another facet of trust is the protection of competences: The providing company will built up know-how when delivering its service thus the customer may fear that the provider transfers the knowledge to a competitor [56]. The factor trust becomes even more important when it is considered that outsourcing decision is hard to withdraw: Competencies are lost over time and thus the customer loses the capabilities and it is difficult and expensive to backshift the outsourced activities [56].

4.4. Human factor

Human factors relate to employees of both the customer and the provider. Outsourcing of activities has a negative influence on the employees of the customer company because they lose duties [57]. Statements regarding the influences on motivation of the provider in the literature differ: working in a customer's facility may have a harmful influence on their motivation [45]. Other authors state that the influence on the motivation is positive because (in a service delivering company) they are working in the core activities of the company and thus see a career opportunity. For a customer this implies the opportunity to raise productivity through these employees [56].

4.5. Technology and performance

As stated for the factor "financial", paying for using a product instead of buying it allows for using the latest innovations without investing. Thus the customer has access to the latest technologies [46]. The customer may expect frequent upgrades [63]. Outsourcing also promises for a better performance (e. g. quality of a machine output, availability, efficiency of resource usage). That factor is also often stated in PSS literature. Reasons are for example a better knowledge of the provider in operation and maintenance as well as incentivizing the provider to reduce machine failures [58].

4.6. Core competencies and activities

Outsourcing of activities allows for focusing on the own core competencies. Hence a customer tends to outsource those activities that do not refer on his core competencies. Vice versa he will refuse from outsourcing those activities that refer on his core competencies [46, 52]. Knowledge management literature gives similar recommendations: capabilities where a company has no or only a low advantage compared to its market environment and that are used infrequently are to be outsourced, whereas capabilities with a high advantage have to be preserved, kept in-house and enhanced [64]. Analogously to core competencies, companies are recommended to outsource those activities that are outside

their core activities. That allows these companies to focus their capital, capabilities and manpower on the business activities with the highest margins [44]. The focus allows for improving the core competitiveness [17]. The implication is similar than to core competencies: companies may refuse from outsourcing their core activities. Outsourcing must not have a negative influence on the own competitiveness, nor today or in the future [55].

4.7. Knowledge transfer and access to knowledge

From a customer perspective there is both a wanted and an unwanted knowledge transfer in the context of outsourcing activities. The unwanted knowledge transfer is directed from the customer to the provider [45] for example when an employee of the provider is delivering a service and is in contact with the customer's employees or is entering his facilities [11]. On the other side companies may hope that knowledge is transferred from the provider's employees to the own ones [56]. Outsourcing allows for accessing specialized knowledge and competencies [51, 56, 59]. Applying specialist knowledge of the provider, better performance of the machines may be achieved or maintenance costs may be reduced [47, 52]. Savings may be realized in those aspects that have not given a high priority by customer and thus are not optimized [49]. This applies especially if the customer perceives a better knowledge related to outsourced activities in the providing company. Literature recommends customer's to outsource to the provider with the best-in world skills [60].

4.8. Knowledge lead of the provider

From the motivation of customers to access and benefit from the expert knowledge of the provider, it may be concluded that the knowledge of a provider related to a specific activity must be superior to those of the customer as well as competitors to be accepted in the market. The challenge of that knowledge lead is that people tend to overestimate their own knowledge and competencies [65]. This implies a reduction of the perceived knowledge lead from the perspective of the customer and an increase of the perceived knowledge gap from the perspective of the provider. A knowledge lead of the providing company compared to customers fosters outsourcing of activities. However the customer has to have a minimum knowledge about these activities for evaluating them [61]. As stated in section 4.1, customers tend to outsource activities for reducing total costs of ownership. However companies may not have knowledge about these costs when buying a machine and are undervaluing them [11]. The customer has to understand why a provider is able to perform an activity more efficient and more effective [46].

5. Conclusions

The discussion of motivations for or against outsourcing of activities in the upper section allows for conclusions on the market acceptance of PSS. The main factors are summarized in Table 1.

Table 1. Main factors on the market acceptance of PSS in B2B environments

| Factor | Explanation |
|----------------------------------|--|
| Pricing | Lower total cost of ownership may have a positive influence on the market acceptance of a PSS. |
| Risk and flexibility | The willingness of a customer to transfer risks to a PSS provider or appreciating a higher flexibility may prefer a PSS to buy a technical product. |
| Trust | Customers must trust the provider that he will deliver the PSS reliably as agreed regarding time, cost and quality. |
| Performance | Customers may expect a superior performance from a PSS compared to a technical product. |
| Knowledge lead of the provider | A knowledge lead (in relation to customers and competitors) of a provider has a positive influence on market acceptance of the offered PSS. Customers may want to benefit of the knowledge of the provider. |
| Core competencies and activities | PSS should not refer on core competencies and activities of the customers. In that case customers will most likely refuse these offers. However, taking non-core activities and non-core competencies from the customer perspective is a success factor. |

This paper contributes to come towards an model for understanding customer acceptance of PSS and designing PSS that have a higher chance to be successful on the market. In future research, these factors have to be verified in empirical studies. Up to now they have been developed on a theoretical basis by reviewing neighbored research fields to PSS. The identified factors focus on B2B environments. Since these factors have been revealed from literature on B2B markets, they cannot be directly transferred to B2C (business-to-consumer) environments. The factor that some consumers want to own a product, as stated by Mont [11] is missing and is not discussed in the considered literature about B2B environments. Altogether the study revealed factors that can be used for estimating the market acceptance of a specific PSS. These factors are applicable for PSS that rely on outsourcing of activities. These are evidences that have a varying and customer-dependent influence. The specific type of PSS influences the significance of these factors. Some specific factors may exist for a specific type of PSS. The factors can be seen as recommendations when designing a PSS. Some of the listed factors such as lower cost, risk transfer and superior performance are coherent with general benefits of PSS. Other factors such as influence on core competencies and activities are stated as benefits of PSS. However that has to be seen from several perspectives since it may also been a huge barrier for market acceptance. The most often promised benefit of PSS is an increased sustainability. However recommendations for (or against) outsourcing of activities do not consider this aspect. The Plant Maintenance Resource Center made a survey in which only 1 out of 29 companies named “improve environmental performance” as a reason for maintenance outsourcing [66]. The presented study could not reveal if improved sustainability is a factor influencing the market acceptance of PSS.

Acknowledgements

We thank the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) for funding this project as

part of the collaborative research centre ‘Sonderforschungsbereich 768 – Managing cycles in innovation processes – Integrated development of product-service-systems based on technical products’.

References

- [1] Schenkl SA, Behncke FGH, Hepperle C, Langer S, Lindemann U. Managing Cycles of Innovation Processes of Product-Service Systems 2013 IEEE International Conference on Systems, Man, and Cybernetis. Manchester: IEEE Computer Society; 2013. p. 918-23.
- [2] Tukker A. Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet. Business strategy and the environment. 2004;13:246-60.
- [3] Kollmann T. Die Messung der Akzeptanz bei Telekommunikationssystemen [The measurement of the acceptance of telecommunication systems]. J Betriebswirtsch. 2000;50:68-78.
- [4] Rogers EM. Diffusion of innovations. New York: Free Press; 2003.
- [5] Schrader U. Consumer acceptance of eco-efficient services: a German perspective. Greener Management International. 1999;105-21.
- [6] Rexfelt O, af Ornäs VH. Consumer acceptance of product-service systems: designing for relative advantages and uncertainty reductions. Journal of Manufacturing Technology Management. 2009;20:674-99.
- [7] Meijkamp R. Changing consumer behaviour through eco-efficient services: an empirical study of car sharing in the Netherlands. Business Strategy and the Environment. 1998;7:234-44.
- [8] Rexfelt O, Hiort af Ornäs H. From consumption to use - consumer requirements in functional sales. In: Horváth I, Rusák Z, editors. TMCE 2008 Symposium Izmir 2008. p. 1495-508.
- [9] Manzini E, Vezzoli C. A strategic design approach to develop sustainable product service systems: examples taken from the ‘environmentally friendly innovation’ Italian prize. Journal of Cleaner Production. 2003;11:851-7.
- [10] Omann I. Product Service Systems and their Impacts on Sustainable Development. Frontiers 2 conference “European Applications in Ecological Economics”. Tenerife 2003.
- [11] Mont O. Drivers and barriers for shifting towards more service-oriented businesses: Analysis of the PSS field and contributions from Sweden. The Journal of Sustainable Product Design. 2002;2:89-103.
- [12] Beuren FH, Gomes Ferreira MG, Cauchick Miguel PA. Product-service systems: a literature review on integrated products and services. Journal of Cleaner Production. 2013;47:222-31.
- [13] Ng I, Yip N. Identifying risk and its impact on contracting through a benefit based-model framework in business to business contracting: case of the defence industry. Proceedings of the 19th CIRP Design Conference—Competitive Design: Cranfield University Press; 2009.
- [14] Ehrlenspiel K, Kiewert A, Lindemann U, Mörtl M. Kostengünstig Entwickeln und Konstruieren [Cost-Efficient Design]. 7. ed. Berlin: Springer; 2014.
- [15] Baines TS, Lightfoot HW, Benedettini O, Kay JM. The servitization of manufacturing: a review of literature and reflection on future challenges. Journal of Manufacturing Technology Management. 2009;20:547-67.
- [16] Mont O. Clarifying the concept of product-service system. Journal of cleaner production. 2002;10:237-45.
- [17] Wang PP, Ming XG, Li D, Kong FB, Wang L, Wu ZY. Status review and research strategies on product-service systems. International Journal of Production Research. 2011;49:6863-83.
- [18] Meier H, Roy R, Seliger G. Industrial Product-Service Systems—IPS2. CIRP Annals - Manufacturing Technology. 2010;59:607-27.
- [19] Aurich JC, Mannweiler C, Schweitzer E. How to design and offer services successfully. CIRP Journal of Manufacturing Science and Technology. 2010;2:136-43.
- [20] Baines T, Lightfoot HW, Evans S, Neely A, Greenough R, Peppard J, et al. State-of-the-art in product-service systems. Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture. 2007;221:1543-52.
- [21] Goedkoop MJ, van Halen CJG, te Riele HJM, Rommens PJM. Product service systems, ecological and economic basics: Ministry of Housing, Spatial Planning and the Environment, Communications Directorate; 1999.

- [22] Tukker A, Tischner U. Product-services as a research field: past, present and future. Reflections from a decade of research. *Journal of Cleaner Production*. 2006;14:1552-6.
- [23] Yu M, Zhang W, Meier H. Modularization Based Design for Innovative Product-Related Industrial Service. *IEEE International Conference on Service Operations and Logistics, and Informatics (IEEE/SOLI 2008)*. Beijing 2008.
- [24] Berkovich M, Leimeister JM, Krcmar H. Suitability of Product development methods for hybrid products as bundles of classic products, software and service elements. *ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE*. San Diego 2010. p. 885-94.
- [25] Isaksson O, Larsson TC, Johansson P. Towards a framework for developing product/service systems. *Functional Thinking for Value Creation*: Springer; 2011. p. 44-9.
- [26] Velamuri VK, Neyer A-K, Möslein KM. Hybrid value creation: a systematic review of an evolving research area. *J Betriebswirtsch*. 2011;61:3-35.
- [27] Cavalieri S, Pezzotta G. Product-Service Systems Engineering: State of the art and research challenges. *Computers in Industry*. 2012;63:278-88.
- [28] Schenkl SA, Schneider D, Mörtl M, Lindemann U. PSS For Preventing Product Imitation. In: Shimomura Y, Kimita K, editors. *The Philosopher's Stone for Sustainability*. Berlin: Springer; 2012. p. 483-8.
- [29] Vandermerwe S, Rada J. Servitization of business: Adding value by adding services. *European Management Journal*. 1988;6:314-24.
- [30] Vasantha GVA, Roy R, Lelah A, Brissaud D. A review of product-service systems design methodologies. *Journal of Engineering Design*. 2012;23:635-59.
- [31] Oliva R, Kallenberg R. Managing the transition from products to services. *International Journal of Service Industry Management*. 2003;14:160-72.
- [32] Sakao T, Sandström GÖ, Matzen D. Framing research for service orientation of manufacturers through PSS approaches. *Journal of Manufacturing Technology Management*. 2009;20:754-78.
- [33] Thomas O, Walter P, Loos P. Product-Service Systems: Konstruktion und Anwendung einer Entwicklungsmethodik [Product-Service Systems: Design and application of a design methodology]. *Wirtschaftsinformatik*. 2008;50:208-19.
- [34] Neely A. Exploring the financial consequences of the servitization of manufacturing. *Operations Management Research*. 2008;1:103-18.
- [35] Brandstötter M, Haberl M, Knoth R, Kopacek B, Kopacek P. IT on demand - towards an environmental conscious service system for Vienna (AT). *3rd International Symposium on Environmentally Conscious Design and Inverse Manufacturing 2003*. p. 799-802.
- [36] Geum Y, Park Y. Designing the sustainable product-service integration: a product-service blueprint approach. *Journal of Cleaner Production*. 2011;19:1601-14.
- [37] Yoon B, Kim S, Rhee J. An evaluation method for designing a new product-service system. *Expert Systems with Applications*. 2012;39:3100-8.
- [38] Morelli N. Developing new product service systems (PSS): methodologies and operational tools. *Journal of Cleaner Production*. 2006;14:1495-501.
- [39] Morelli N. Designing Product/Service Systems: A Methodological Exploration. *Design Issues*. 2002;18:3-17.
- [40] Sundin E, Lindahl M, Ijomah W. Product design for product/service systems: design experiences from Swedish industry. *Journal of Manufacturing Technology Management*. 2009;20:723-53.
- [41] Finken KH, McAloone TC, Avlonitis V, Garcia i Mateu A, Andersen JB, Mougard K, et al. *PSS Tool Book*. PROTEUS Workbook Series 2013.
- [42] Herzberger P, Behncke FGH, Schenkl S, Lindemann U. Interactive modeling and evaluation of product-service-systems. In: Lindemann U, Venkataraman S, Kim YS, Lee SW, editors. *19th International Conference on Engineering Design 2013 (ICED13)*. Seoul, Korea 2013.
- [43] Panshef V, Dorsam E, Sakao T, Birkhofer H. Value-chain-oriented service development by means of a two-channel service model. *International Journal of Services Technology and Management*. 2009;11:4-23.
- [44] Ford D, Farmer D. Make or buy—a key strategic issue. *Long Range Planning*. 1986;19:54-62.
- [45] Gómez J, Crespo A, Moreu P, Parra C, Díaz VG. Outsourcing maintenance in services providers. *Safety, Reliability and Risk Analysis: Theory, Methods and Applications—Martorell et al (eds)*. 2009:829-37.
- [46] Strumf R. Outsourcing der globalen After-Sales-Logistik — Trend mit Nutzen oder Risiko? [Outsourcing the global after-sales logistics - Trend with benefit or risk?]. In: Barkawi K, Baader A, Montanus S, editors. *Erfolgreich mit After Sales Services*: Springer Berlin Heidelberg; 2006. p. 299-311.
- [47] Siemer F. Gestaltung von Betreibermodellen für anlagentechnische Unternehmensinfrastrukturen [Design of operator models for plant engineering enterprise infrastructure]. Munich: TCW; 2004.
- [48] Hornschild K, Kinkel S, Lay G. Höhere Wettbewerbsfähigkeit durch produktbegleitende Dienstleistungen: Betreibermodelle im deutschen Maschinenbau [Increased competitiveness through product-related services: operator models in the German mechanical engineering sector]. *DIW Wochenbericht*. 2003;70:775-9.
- [49] Lay G, Schröter M. Mit Service zu neuen Geschäftsmodellen — ökonomische Potenziale identifizieren [With service to new business models - identify economic potential]. In: Barkawi K, Baader A, Montanus S, editors. *Erfolgreich mit After Sales Services*: Springer Berlin Heidelberg; 2006. p. 333-47.
- [50] Platts K, Probert D, Canez L. Make vs. buy decisions: A process incorporating multi-attribute decision-making. *International Journal of Production Economics*. 2002;77:247-57.
- [51] Buck-Lew M. To outsource or not? *International Journal of Information Management*. 1992;12:3-20.
- [52] Garrel J, Dengler T, Seeger J. Industrielle Betreibermodelle [Industrial operator models]. In: Schenk M, Schlick C, editors. *Industrielle Dienstleistungen und Internationalisierung*: Gabler; 2009. p. 267-330.
- [53] Hypko P, Tilebein M, Gleich R. Benefits and uncertainties of performance-based contracting in manufacturing industries: An agency theory perspective. *Journal of Service Management*. 2010;21:460-89.
- [54] Jauch LR, Wilson HK. A strategic perspective for make or buy decisions. *Long Range Planning*. 1979;12:56-61.
- [55] Becker J, Beverungen D, Knackstedt R. Wertschöpfungsnetzwerke von Produzenten und Dienstleistern als Option zur Organisation der Erstellung hybrider Leistungsbündel [Value networks of producers and service providers as an option for organizing the delivery of Product-Service Systems]. In: Becker J, Knackstedt R, Pfeiffer D, editors. *Wertschöpfungsnetzwerke*. Heidelberg: Physica-Verlag; 2008. p. 3-31.
- [56] Campbell JD. Outsourcing in maintenance management: A valid alternative to self-provision. *Journal of Quality in Maintenance Engineering*. 1995;1:18-24.
- [57] Bertolini M, Bevilacqua M, Braglia M, Frosolini M. An analytical method for maintenance outsourcing service selection. *International Journal of Quality & Reliability Management*. 2004;21:772-88.
- [58] Ng ICL, Nudurupati SS. Outcome-based service contracts in the defence industry – mitigating the challenges. *Journal of Service Management*. 2010;21:656-74.
- [59] van de Water H, van Peet HP. A decision support model based on the analytic hierarchy process for the make or buy decision in manufacturing. *Journal of Purchasing and Supply Management*. 2006;12:258-71.
- [60] Kakabadse N, Kakabadse A. Critical review – Outsourcing: a paradigm shift. *Journal of Management Development*. 2000;19:670-728.
- [61] Bustinza OF, Molina LM, Gutierrez-Gutierrez LJ. Outsourcing as seen from the perspective of knowledge management. *Journal of Supply Chain Management*. 2010;46:23-39.
- [62] Straub A. Maintenance contractors acting as service innovators. *Construction Innovation: Information, Process, Management*. 2011;11:179-89.
- [63] Mörtl M. Entwicklungsmanagement für langlebige, upgradegerechte Produkte [Development management for durable, upgradeable products]. Munich: Dr. Hut; 2002.
- [64] Probst G, Raub S, Romhardt K. *Managing Knowledge: Building Blocks for Success*. 7. ed. Hoboken: John Wiley & Sons; 1999.
- [65] Dunning D, Heath C, Suls JM. Flawed Self-Assessment. Implications for Health, Education, and the Workplace. *Psychological science in the public interest*. 2004;5:69-106.
- [66] Plant Maintenance Resource Center. *Maintenance Outsourcing Survey Results*. 2001.