Undecidable? Categorization and its effects
Kuijken, B.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Chapter 2

EFFECTIVE PRODUCT-SERVICE SYSTEMS

Authors  B. Kuijken, G. Gemser, N.M. Wijnberg

Currently, this paper is under review. This paper was presented at the 19th IPDMC, Manchester, U.K., June 17-19, 2012, and at the 8th International Conference on Design & Emotion, London, U.K., September 12-14, 2012.
Abstract

Producers increasingly offer bundles of products and services in product-service systems (PSS). However, literature on PSS’ is limited and a lack of consensus about how a PSS should be understood makes it difficult to develop a PSS that generates competitive benefits in a systematic fashion. The primary purpose of this paper is to propose a new framework that defines products, services, and PSS from the perspective of how these offerings create value for the customer, and to show how this framework can contribute to the development of competitively effective PSS’. The framework builds on the core idea that products and services differ from each other with regard to the value that is created by the tangibility or non-tangibility and the interactions or non-interactions between producers and customers; this is presented in a 2x2 matrix. Subsequently, principles that are important for identifying and developing effective PSS’ are proposed. Those principles include that the product and service elements of the PSS should have sufficient autonomous value to be sold separately on the market, they should come from different quadrants of the 2x2 matrix, and the combination of product and service elements should create synergy. Through a survey, our ideas were empirically tested among product and service developers. In addition, through an experiment that used a sealed bid second price auction, how to effectively position a PSS in the market was tested. This paper concludes with a discussion.
2.1 Introduction

Increasingly, producers develop and market product-service systems (PSS) to gain a competitive advantage (e.g. Antioco et al., 2008; Manzini and Vezzoli, 2003). PSS’ involve offerings that include one or more product functionality and one or more associated service functionality. While a new firm can decide to offer PSS’ from the start, the usual path towards such an offering is that a firm that already offers either products or services adds the missing component to its offerings. Service providers can choose to offer PSS’ by adding products to existing services (‘productization’). For them, this bundling of products and services can be beneficial because it can result in, among other things, more efficiency (reduction of costs). For example, direct, personal contact with customers is (partly) replaced by (intelligent) products, such as robots to assist care providers.

Another benefit is that by integrating a product and service into a PSS, it is possible to make a service more tangible and easier to understand and evaluate before a purchase (Jaakkola, 2011). However, the opposite movement, adding services to products or “servitization” is much more common and has received much more attention from researchers (see especially Neely, 2008; 2010). The PSS concept has, in general, been discussed in terms of the manufacturing industry that shifts its business focus from designing and selling physical products only, to designing and selling a system of products and services (e.g., Manzini and Vezzoli, 2003; Santamaria, Nieto, and Miles, 2012; Ulaga and Reinartz, 2011; Vandermerwe and Rada, 1988).

For example, to profit from the rapid growth of the 3D printing market, some manufacturers of printing machines are exploring ways to offer 3D printing ‘on demand’ services to, for example, designers and artists. For manufacturers, bundling of products and services is advantageous because services tend to lock the customer into a long-term relationship (Cohen, Agrawal, and Agrawal, 2006; Tukker, 2004; Vandermerwe and Rada, 1988). PSS’ either provide a means to lower costs, for either the PSS providers or their customers (Ulaga and Reinartz, 2011), or a means to differentiate similar offerings and increase the (perceived) added value of these offerings (Gebauer and Friedli, 2005; Penttinen and Palmer, 2007). PSS’ can bring products closer to the customer and enable customization and tailor made solutions to a larger extent than traditional products. PSS’ can thus create a more personalized experience.
As Neely (2008) notes, servitization concerns manufacturers in the developed world who add services to products that would otherwise be offered at other positions in the value system, usually further downstream. They would be offered by either specialized service providers, such as repair firms; by retailers; or by other manufacturers who use the original product in their products and add the service to the composite resulting product. One example of this is a firm that produces cooling fans and sells them to a laptop manufacturer. If the fan manufacturer were to offer consulting services to the laptop manufacturer concerning how to optimize other components of the laptop to particular fans, the fan manufacturer could be considered to be offering a PSS to its industrial customer. Interestingly, the firm that produces cooling fans could also offer guarantee and repair services for these fans to the final customers. In this servitization case, the fan manufacturer would offer a PSS to final customers, bypassing the laptop manufacturer.

As is clear from this example, whether and what kind of PSS to offer, and how to do so, are questions that are highly relevant from the perspective of industrial marketing and b2b, not just for firms that offer their goods directly to consumers. Manufacturers located at different stages of the value system will attempt to create and appropriate a larger share of the eventual value to the final customers (Mol, Wijnberg, and Carroll, 2005); offering a PSS as a result of the process of servitization can be a successful strategy for achieving this.

Although in theory there are many benefits of a PSS, in practice producers often struggle to enhance their performance by developing a PSS (Baveja et al., 2004; Neely, 2008; Stanley and Wojcik, 2005; Ulaga and Reinartz, 2011). In part, this seems to be due to the facts that the concept of a PSS is still emerging (Sundin, Lindahl, and Ijomah, 2009), the literature focusing on PSS’ is limited (see for a review Reim, Parida, and Örtqvist, 2014), and there is a lack of clarity or at least consensus about how a PSS should be understood. These factors make it harder to develop PSS’ that have the greatest competitive benefits in a systematic fashion (Spring and Araujo, 2009). The primary purpose of this paper is to propose a new framework that defines products, services, and PSS’ from the perspective of how these offerings create value for the customer, and to show how this framework can contribute to developing competitively effective PSS’, especially for firms that consider the servitization route.
The sections below discuss the previous literature on PSS,’ to propose a framework that enables the offering of a new definition of PSS. Subsequently, the results of two empirical studies are presented. One of these studies is a survey-based study of product and service developers; this study established that the way these professionals think and make decisions about the characteristics of products versus services corresponds well to the framework and definition proposed here. The second study is an experiment that used an auction website that one of the authors developed, to study how consumers value the product and service components of a PSS and how their valuation is affected by whether or not the offering is explicitly described as a PSS. In the last section a discussion and suggestions for future research are provided.

2.2 Theory

2.2.1 Defining PSS

There is no generally accepted definition of a PSS (Mont 2002a). A basic description of a PSS is a system that consists of products and services that fulfil customers’ needs (Goedkoop et al., 1999; Mont, 2002b; Manzini and Vezzoli, 2003; Tukker, 2004). The act of combining products and services is essential to a PSS. In the existing literature products and services are generally considered different. The four main differences between products and services that were identified in the existing literature are: intangibility, simultaneity, heterogeneity, and unstorability (or perishability) (Easingwood, 1986; Jaw, Lo, and Lin, 2010; Johne and Storey, 1998; Morelli, 2002; Nijssen et al., 2006). Intangibility or the degree of material intensity refers to the fact that services are not material-based. Being material-based also implies that something can be physically stored. Unstorability or perishability relates to the fact that services only exist in time and not in space; thus, they cannot be stored.

Simultaneity deals with the simultaneous production and the consumption of services, which implies interactions between producers and consumers. As noted by Santamaria et al., (2012, p. 147): “Interaction with customers is a distinctive and – in some services – a fundamental element of the service process.” Indeed, the design of customer interactions – how the service is to be delivered to the customers – has been acknowledged as an essential element of new service development (Johne and Storey, 1988; Secomandi and Snelders,
Due to this interaction, services tend to be heterogeneous. Heterogeneity makes the service likely to be experienced differently each time it is consumed. Thus, the four differences can be reduced to two core differences with respect to tangibility and producer-consumer interaction. The next subsection builds on this core distinction, but first what it means to combine products and services in a PSS is explored.

Shostack (1977; 1982) proposes that all products and services consist of combinations of product and service elements, and that the balance between those elements determines whether the combination is perceived as a product or a service. However, for the development and marketing of effective PSS’, it seems beneficial to establish when a product with service elements or a service with product elements becomes an effective PSS. If almost anything can be labeled as a PSS, the PSS term appears meaningless. This paper proposes that, to develop an effective PSS – in the sense that customers perceive the added value of the PSS –, the products and services that make up the PSS should have ‘autonomous’ value for the customers. ‘Autonomous value’ means that the products and services that comprise the PSS could be sold separately as stand-alone offerings on the market.

It may be that a product or service is specifically developed for the PSS and it did not exist as an autonomous offering before the market introduction of the PSS. However, whenever the product or service has such customer value that in theory it could be sold separately, it fulfills the criteria. For example, some services are required during the purchase decision – e.g. to make the customer buy the offering – but do not possess enough value to make customers willing to pay extra for them. Next to having autonomous value, the combination of the products and service elements in a PSS should be ‘super additive’ or synergetic (i.e. the whole is valued higher than the sum of its parts) rather than ‘additive’ (i.e. the whole equals the sum of its parts) or sub additive (i.e. the whole is less than the sum of its parts). This is in line with Shankar, Berry, and Dotzel (2007) who suggest that PSS’ are systems that create more customer benefits than if the products and services were available separately.

From a business perspective it seems beneficial to invest in a PSS, if in the perception of the customer, the PSS adds more value than when the product and service are sold separately on the market. PSS producers should thus make sure that customers perceive the added value of this combination. Unfortunately this is not always the case. For example, as demonstrated by Ulaga and Reinartz (2011), for PSS’ that
ensure proper functioning of the seller’s product during all stages of its lifecycle (e.g. product lifecycle services such as maintenance contracts or take-back agreements), the services provided were considered a ‘must have’ by customers. Thus, these customers showed a low willingness to pay extra for such services. In other words, the services did not provide significant added value for the customers, and the PSS was not effective.

In addition to developing PSS’ that are effective, it is also essential to effectively position the PSS in the market. PSS’ combine product and service elements; thus, they cross categorical boundaries. This is relevant because categorization is an essential element of human information processing (Eguaras, Domezain, and Grijalba, 2012). Indeed, as shown in prior research, when a product crosses categorical boundaries, customers’ experience more difficulty categorizing this product (Gregan-Paxton et al., 2005; Moreau et al., 2001), which in turn negatively affects customers’ product evaluations (Goode et al., 2013; Gregan-Paxton, et al., 2002; Noseworthy and Trudel, 2011). In addition, research in marketing and psychology has suggested that people mainly use knowledge from one category to make sense of and evaluate new products (Moreau et al., 2001; Murphy and Ross, 2010; Rajagopal and Burnkrant, 2009), which may result in customers not perceiving the synergetic benefits of a PSS. Gregan-Paxton et al. (2005), however, found that customers were able to hold multiple category beliefs about products that cross multiple categories when both categories are communicated at the same time. Therefore, this paper proposes that in the case of PSS’ – in which both the product and the service elements have autonomous added value, it is important that the product and the service elements are communicated and emphasized in order to generate synergy in the eyes of customers.

2.2.2 PSS: Value resulting from what is tangible or intangible or from the presence or absence of producer-consumer interaction

As discussed above, products and services differ in two basic ways: with respect to tangibility and to interaction. The tangibility is part of what the design literature terms the ‘manifestation’, which describes the form or expression of the offering (Hekkert and van Dijk, 2011). Two related points must be made here. First, if we look at products and services from
an economic perspective, focusing on value creation, the essential issue is whether the tangible or intangible elements add value. Second, few products are exclusively tangible and even fewer services are exclusively non-tangible. Products may possess aspects that are intangible and services may have tangible aspects. This has an effect on how customers use and experience the products or services (Margolin, 1997; Schifferstein and Hekkert, 2011). However, not all intangible aspects of a product can contribute to the economic value of that product, nor can all tangible aspects of services add economic value.

The second core distinction that was noted is the presence of (repetitive) interaction between producers and customers, and particularly the degree to which this interaction contributes to the value of the offering. Of course, tangibility and interaction can interact in the sense that being tangible or intangible can have a strong influence on the type of interaction that a customer has with an offering (Boztepe, 2007). In the case of a manifestation with high material intensity (a product), interaction is mainly physical in nature (a customer can touch, smell, see, and hear the product). Interaction is also rather ‘static’; the type of interaction a customer can have with the product is determined beforehand and in general cannot change over time. However, interaction as a core characteristic of services denotes producer-consumer interaction. In the case of services, this producer-consumer interaction is mainly ‘non-material’ and dynamic. Even though a blue print can be made of the different stages in a service, the interaction cannot be fully ‘pre-programmed’ since services are co-created with customers, and these customers and the circumstances in which the services are provided may change each time a service is delivered (Bitner, Ostrom, and Morgan, 2008). This ‘real’, dynamic interaction between producer and customer means that they adapt their decisions and behavior to each other in a way that cannot be completely pre-programmed, and this real interaction must create additional value – as perceived by the customer. This interaction can occur at different points of time in a life cycle of a service or a PSS. Interaction generally takes place before or during a purchase, but it may also take place after a purchase. Indeed, one of the main motives of PSS providers for offering both products and services is that PSS’ allow for more long-term relationships between a supplier and a customer.

The matrix shown below in Figure 2.1 shows both of these dimensions. The use of arrows in the matrix indicates that the dimensions are not dichotomous (e.g. an offering scores either high or
low on intangibility; an offering asks either for no or high interaction); rather, they are continuous (an offering can score according to all different kinds of degrees on the degree of intangibility and interaction needed). The matrix also suggests the symmetric character resulting from the focus on value creation. The value of a product resides in the tangible characteristics, but a product can also create additional value because no interaction is needed (for instance, a customer prefers an iRobot Roomba over a cleaning lady or a book over a lecture), the value of a service resides in the interaction, but can create additional value because it is intangible (for instance, you do not need space in your house for the lectures you have attended, while books require space).

An offering that scores low on both dimensions is a straightforward product – for example, a stapler – in the lower-left quadrant of the matrix; an offering that scores high on both dimensions is a straightforward service – for example, psychotherapy in the upper-right quadrant. In the upper-left quadrant there are offerings, the value of which mainly has to do with intangible characteristics – for example a musical performance on a CD – though interaction between producers and customers is minimal. In the lower-right quadrant are offerings, the value of which mainly has to do with tangible characteristics, but that need producer-customers interaction to fully create the value – for example a meal in a good restaurant.

**Figure 2.1** Product-service 2x2 matrix
To consider something an effective PSS, it should consist of a) more than one offering that has a (potential) separate final market, b) when combining the separate offerings, the resulting combination should create synergy (superadditive value) in terms of being valued more together (by customers) than the sum of the separate components, and c) the offerings should come from different quadrants of the 2x2 matrix (see Table 2.1). If the offerings come from the lower-left and upper-right quadrants of the matrix then one has the most ‘pure’ PSS, with the original components contrasting maximally.

**Table 2.1 PSS principles**

1. PSS’ should consist of more than one offering that has a (potential) separate final market.

2. Combining the separate offerings should result in superadditive value.

3. The offerings should come from different quadrants of the 2 x 2 matrix.

The two dimensions identified above to identify ‘effective’ PSS’, the degree of tangibility and the degree of interaction, are not only valid from a business perspective, they are also valid from a product development perspective. Indeed, when designing PSS’, the main challenges for designers include creating coherence between the tangible aspects of the product and the non-tangible aspects of the services and, on the other hand, designing customer-friendly interactions between producers and customers (Ulaga and Reinartz, 2011).

To test ideas regarding the proposed 2x2 product-service matrix (Figure 2.1), innovation experts were queried. To test the proposed PSS principles, customers’ willingness to pay for a combination of product and service elements that – in theory – can be identified as a PSS was measured. An experiment was also conducted that tested different ways of positioning this combination. Below, we discuss the set-up and outcomes of these two empirical studies in more depth.
2.3 Study 1: Survey among product and service developers

2.3.1 Method

This first study examined whether product and service developers, who are the core people who decide which characteristics of an offering could generate value to consumers, consider these characteristics similar to the way we considered the differences between products and services, leading up to our definition of a PSS. To test the proposed 2x2 product-service matrix (Figure 2.1) an online survey was sent to two groups of experts. The first group of experts consisted of product and service development managers who were members of a Dutch association for product and service development (PDMA). In total 84 development managers were contacted, of which N = 37 participated in this study (a response rate of 44%). The second group of experts consisted of experienced product and service designers who were participating in a Dutch research project named Creative Industries Scientific Program (CRISP), of which this current study is part of.

CRISP focuses on generating and disseminating knowledge about how to develop and design PSS’ (www.crispplatform.nl). Several design agencies, multinational organizations, and universities are participating in this project. The two largest design agencies that participated in CRISP were selected. In total 63 designers working for these two design agencies were identified and contacted, of whom N = 44 – evenly spread across the two agencies – agreed to participate (a response rate of 70%). The two groups of experts added up to N = 81, of which 77.8% were men. The average age was 38.7 and the average years of work experience was 11.75. The majority of this group (88.9%) indicated that they had experience with the development or design process of a PSS.

This survey focused on the extent to which the experts agreed with the proposed distinction between products and services. Respondents were asked questions to assess whether value creation by means of adding tangible elements to an offering and value creation by means of (repetitive) interaction moments were more important for products or for services. Respondents could respond using a five-point scale (1 = only important for products, to 5 = only important for services).
2.3.2 Results

Table 2.2 provides descriptive statistics and correlations for the relevant variables used in this study. The means show that the value creation through tangible elements is — according to our experts — more important for products than for services (i.e. the mean is closer to zero than to five). The means of the importance for value creation through interaction moments and repetitive interaction moments show that these two elements are more important for services than for products. In addition, these two elements are positively correlated ($r = .60, p < .01$).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>s.d.</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Importance of tangible elements: products vs. services</td>
<td>1.90</td>
<td>.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Importance of interaction moments: products vs. services</td>
<td>3.44</td>
<td>.87</td>
<td>-.12</td>
<td></td>
</tr>
<tr>
<td>3. Importance of repetitive interaction moments: products vs. services</td>
<td>3.63</td>
<td>1.07</td>
<td>.07</td>
<td>.60**</td>
</tr>
</tbody>
</table>

$n = 81, ** p < .01$

To investigate whether the differences in means were significant, a paired sample t-test was conducted. Table 2.3 provides the results of the paired sample t-test. The results show that there is a significant difference between the means of the importance of value creation through tangible elements and (repetitive) interaction moments ($t = -11.95, p < .01$). This implies that the respondents in our sample considered tangible elements more important for products than for services in terms of characteristics that create value. The other way around counts for (repetitive) interaction moments, which were considered more important for services than for products in terms of
characteristics that create value. To further investigate the robustness of these results, whether the two different groups of experts (i.e. developers and designers) showed consensus in their answers was analyzed; this was indeed the case, since for the relevant variables in this study there was no significant difference between the two groups of experts.

Table 2.3  Paired sample t-test to measures differences in means for the importance of value creation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Difference</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Importance of tangible elements</td>
<td>1.54</td>
<td>-11.95**</td>
<td></td>
</tr>
<tr>
<td>Importance of interaction moments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Importance of tangible elements</td>
<td>1.73</td>
<td>-12.70**</td>
<td></td>
</tr>
<tr>
<td>Importance of repetitive interaction moments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Importance of interaction moments</td>
<td>0.22</td>
<td>-1.89</td>
<td></td>
</tr>
<tr>
<td>Importance of repetitive interaction moments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n = 81, ** p < .01

2.4  Study 2: Experimental auction

2.4.1 Method

In this second study we conducted an experiment to study the effects of how a good that has product and service characteristics is presented to consumers on willingness to pay. The goal was to determine whether emphasizing both the product and the service elements – and therefore emphasizing the PSS character of the PSS – elicited a higher willingness to pay (WTP) than emphasizing either the product or the service elements alone. In addition, whether emphasizing the product elements compared to the service elements (or vice versa) of a PSS had a significant effect on WTP was tested.
This experiment was conducted using a Vickrey auction – also called a second-price-sealed-bid auction (Vickrey, 1961). In a Vickrey auction respondents place one bid and do not see what others are bidding. The winner of the auction pays the second highest bid. An important characteristic of a real second-price auction – compared to measuring hypothetical WTP – is that respondents have a stronger incentive to bid their true WTP. Research shows that experiments measuring hypothetical WTP overstate the amount that customers are willing to pay by up to three times compared to real WTP (List and Gallet, 2001).

Respondents were invited by email to participate in the auction. Upon receiving the invitation respondents had 12 hours to start the auction by clicking the link in the email. Respondents first had to participate in two trial auctions to become familiar with the second-price auction. After completing the trial auctions and agreeing with the rules of the auction the treatment was shown. From that moment they had six minutes to place and confirm their bid. After confirming their bid they answered a few questions regarding their demographics (e.g. gender, age, address). In addition, they were asked whether or not they thought that the combination of the specific product and service was a successful combination (1 = Yes, 2 = No).

After closing the auction all respondents were sent an email that mentioned whether or not they won the auction. In the email to the respondents who did not win the auction the amount of the bid of the winner and the second highest bid that the winner had to pay were provided. The email to the winner mentioned his or her own bid and the second highest bid that he or she had to pay. An invoice was also added and after paying the invoice, the good was sent to the winner.

The auction object consisted of a combination of an activity tracker (the product element) and an online (but real) personal coach (the service element). The objective of this combination was to make customers more active and healthy. The activity tracker measures customers’ daily activity. The data can be viewed on a computer. The online personal coach gives advice to the customer based on this data. Both elements can be found separately on the market and have autonomous value. That is, devices that measure customers’ daily activity (e.g. from simple pedometers to more advanced devices that measure much more than the steps one takes) can be found in stores. Online personal coaches – which customers have to pay for – are also found on the market. Furthermore, it was expected that combining the
activity tracker with the personal coach would result in a PSS with super additive value because the online personal coach could provide more grounded advice, due to the data collected through the activity tracker; thus, customers would be motivated to use the activity tracker (more often) because of the feedback that they could receive from the personal coach.

The experiment followed a 1x3 design that contained three different treatments. Respondents were randomly assigned to one of the three experimental conditions. The treatments varied in the degree to which the PSS was positioned as a product, a service, or a combination of the two. In all treatments the researchers communicated – by means of a description and an image – both the product and the service elements. However, depending on the treatment either the product or the service was emphasized by adding the category label and increasing the size of the relevant description and image. The treatment that emphasized the combination showed the category labels of the product and the service, and both descriptions and images were the same size.

Respondents were recruited through two Dutch panel agencies. Those agencies sent an email to a part of their panel – which was representative of the Dutch population – asking the panel members to sign up for the auction platform (respondents signed up at: www.veylinx.com). Panel members at those agencies can earn points that can be exchanged for gifts or discounts. By offering them points the members were incentivized to sign up. Both panel agencies offered a similar number of points that represented a similar amount of monetary value. Whether or not the responses between the respondents from the two separate panel agencies differed was measured, and they did not. A total of 1776 panel members signed up. Those panel members were invited to participate in the auction, and 44.20% (N = 785) of them completed the auction by placing a bid and answering a short survey. The panel members did not receive an incentive to participate in the actual auction. The average age was 43 years and 50.4% were female.

2.4.2 Results

Table 2.4 shows the descriptive statistics for the three treatments. The N between the treatments differs slightly because respondents were randomly assigned to one of the treatments prior to sending the invitation. In addition, they had the opportunity to abort the auction. For both treatments the minimum bid was zero Euros. This can be
explained by the fact that we invited a representative sample of the Dutch population, including people who were apparently not interested in the product. On average 38% placed a bid equal to zero Euros. As shown in Table 2.4, our respondents were willing to pay more for the PSS when it was positioned as a PSS instead of a product or service.

Table 2.4 Descriptive statistics of WTP (in Euro’s) per treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>S.E. Mean</th>
<th>Std. deviation</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product-focused</td>
<td>269</td>
<td>8.18</td>
<td>.74</td>
<td>12.07</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>Service-focused</td>
<td>230</td>
<td>6.70</td>
<td>.96</td>
<td>14.63</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>PSS-focused</td>
<td>286</td>
<td>8.89</td>
<td>.74</td>
<td>12.51</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>All treatments</td>
<td>785</td>
<td>8.04</td>
<td>.47</td>
<td>13.04</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

To test whether the means were significantly different, a Mann-Whitney test was performed. This non-parametric test was used because the dependent variable (i.e. WTP) was not normally distributed. Table 2.5a shows that respondents were willing to pay more (Mann-Whitney $U = 260.46$, $Z = -4.206$, $p = .000$) when they were shown the treatment in which both elements were equally emphasized (the PSS-focused treatment) compared to the treatments in which the service elements were emphasized.

If, however, the WTP between the product-focused treatment and the PSS-focused treatment is compared (see Table 2.5b) the WTP for the PSS focused treatment is higher, but this result is not significantly different (Mann-Whitney $U = 371.19$, $Z = -.730$, $p = .466$).
Table 2.5a. Mann Whitney test results for differences between service-focused treatments and the PSS-focused treatment

<table>
<thead>
<tr>
<th></th>
<th>Mean rank: Service-focused (N)</th>
<th>Mean rank: PSS-focused (N)</th>
<th>Mann Whitney U</th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP</td>
<td>2.29 (230)</td>
<td>2.83 (268)</td>
<td>260.46</td>
<td>-4.21</td>
<td>.00</td>
</tr>
<tr>
<td>WTP of top 50% of the bids</td>
<td>1.06 (115)</td>
<td>1.52 (147)</td>
<td>55.10</td>
<td>-486</td>
<td>.00</td>
</tr>
<tr>
<td>WTP of top 50% of the bids excluding the respondents who did not consider the PSS a good combination</td>
<td>0.80 (82)</td>
<td>1.03 (103)</td>
<td>31.50</td>
<td>-2.98</td>
<td>.00</td>
</tr>
</tbody>
</table>

Table 2.5b Mann Whitney test results for differences between product-focused treatments and the PSS-focused treatment

<table>
<thead>
<tr>
<th></th>
<th>Mean rank: Product-focused (N)</th>
<th>Mean rank: PSS-focused (N)</th>
<th>Mann Whitney U</th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP</td>
<td>2.73 (269)</td>
<td>2.83 (286)</td>
<td>371.19</td>
<td>-.73</td>
<td>.47</td>
</tr>
<tr>
<td>WTP of top 50% of the bids</td>
<td>1.37 (139)</td>
<td>1.50 (147)</td>
<td>92.69</td>
<td>-1.37</td>
<td>.17</td>
</tr>
<tr>
<td>WTP of top 50% of the bids excluding the respondents who did not consider the PSS a good combination</td>
<td>0.92 (93)</td>
<td>1.04 (103)</td>
<td>42.15</td>
<td>-1.46</td>
<td>.14</td>
</tr>
</tbody>
</table>

When the product-focused treatment was compared with the service-focused treatment (see Table 2.5c), a significant difference
(Mann-Whitney $U = 254.27$, $Z = -3.566$, $p = .000$) was found with the product-focused treatment, resulting in a higher WTP.

**Table 2.5c** Mann Whitney test results for differences between product-focused treatments and service-focused treatment

<table>
<thead>
<tr>
<th></th>
<th>Mean rank: Product-focused (N)</th>
<th>Mean rank: Service-focused (N)</th>
<th>Mann Whitney U</th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP</td>
<td>2.70 (269)</td>
<td>2.26 (230)</td>
<td>254.27</td>
<td>-3.57</td>
<td>.00</td>
</tr>
<tr>
<td>WTP of top 50% of the bids</td>
<td>1.45 (139)</td>
<td>1.07 (115)</td>
<td>561.60</td>
<td>-4.10</td>
<td>.00</td>
</tr>
<tr>
<td>WTP of top 50% of the bids excluding the respondents who did not consider the PSS a good combination</td>
<td>0.95 (93)</td>
<td>0.80 (82)</td>
<td>315.20</td>
<td>-1.99</td>
<td>.05</td>
</tr>
</tbody>
</table>

As a robustness check, Tables 2.5a, 2.5b, and 2.5c also show the differences in the means of WTP for the top 50% of the bids and the means of WTP for the top 50% of the bids, excluding the respondents who indicated that they did not consider the product and service elements in the PSS a successful combination. These two separate measures reduced the amount of zero bids and the number of people who might be less interested in the PSS because they did not think the PSS was a successful combination. The results show similar effects to the analysis in which only WTP was used.

Together, the results show that our respondents were willing to pay more when the PSS-focused treatment was used compared to the service-focused treatment. These results, however, do not show a significant difference for when the PSS-focused treatment was compared to the product-focused treatment. The $p$-value declined when focusing on the respondents that might be more interested in the PSS (i.e. selecting the top 50% of the bids and eliminating the respondents who did not think the PSS was a successful combination), but it is still not significant. Furthermore, our respondents were willing to pay significantly more in the case of the product-focused treatment
compared to the service-focused treatment. Overall, the results suggest that the PSS tested in this study is considered a weak PSS, as evidenced by the relatively low WTP for the service component of the PSS. As a PSS it is not entirely effective, because equally emphasizing both the product and the service elements did not result in a significant increase in customers’ WTP compared to the product-focused treatment. However, the results do suggest that customers’ WTP can be strongly influenced by whether the positioning of the good is PSS-, product-, or service-focused.

2.5 Discussion

In this study a framework that can be used to identify and develop effective PSS’ is introduced. Offering PSS’ means combining products and related services, and this often requires that a firm positioned in one stage of the value system offers additional products or services that are or could be offered by other firms in other stages (Neely, 2008, 2010). In such cases, the decision of whether or not to offer a PSS also requires a particular strategic choice with regard to vertical competition for the greater share of value to the final customer (Mol et al., 2005). If a B2B firm, similar to a B2C firm, decides to offer a PSS, they must decide which product and service elements will be combined and how it will be offered; this requires a clear understanding of whether and how a PSS creates value for the final customer. The main purpose of this paper is to propose a framework that allows firms to consider these decisions in a systematic fashion and to show how this framework can be used to investigate specific aspects that impact the effective development and marketing of PSS’.

This framework builds on the core idea that products and services differ from each other with regard to the value that is created by the tangibility or non-tangibility and the interaction or non-interaction between producers and customers. The findings suggest that the products and services that make up the PSS should have ‘autonomous’ value for the customer, meaning that they could be sold separately as stand-alone offerings on the market. This distinction helps to separate ‘real’ PSS’ from offerings that, in essence, are either products or services even though they combine service and product elements. The proposal that the products and services that make up a PSS should have autonomous value does not preclude another important element of
effective PSS'; namely, that the product and service elements that are combined in the PSS should be combined in such a fashion that synergy is created.

Two empirical studies provide evidence of the validity of this framework. In the first study, for the sampled product/service developers agreed with the proposed difference between products and services (i.e. tangibility and interaction). The second study examined how to effectively position a PSS in the market by measuring whether emphasizing the PSS character of a PSS, compared to emphasizing either the product or the service elements, had an effect on customers' WTP. The results show that the manner in which a PSS is positioned in the market can indeed have a strong effect on customers' WTP. The PSS tested in this study did not appear to be an effective PSS because emphasizing both the product and service elements compared to only the product elements did not result in a significant increase in customers' willingness to pay, and – therefore – did not create synergy. From a business point of view, the service elements in the examined combination could be omitted because they did not significantly increase customers’ willingness to pay.

2.5.1 Managerial implications

For product producers that want to engage in servitization in order to develop PSS', it is important to test whether the product and the service elements – when they are combined – create synergy in terms of being valued more together than as separate parts. As found by Ulaga and Reinartz (2011), managers consider the realization of synergy in PSS creation a major challenge. The current trend is that manufacturers combine their existing offerings with new services. Currently PSS' are not often developed ‘from scratch’. However, in order to develop a PSS in which product and service elements interact synergistically for value creation, rather than in a mere additive manner, this may be required.

As a suggested first step for creating an effective PSS, producers should choose to combine products and services that, at least in theory, have autonomous value on the market and, when combined, result in a PSS that is valued more than when the product or service was separately available on the market. As a second step, they should examine the degree of tangibility and the degree of interaction. For an effective PSS, there should be a high degree of tangibility (product elements) and a
high degree of interaction (service elements). Third, products and services should be combined in a coherent, synergetic fashion. Synergy can be created by designing PSS’ with different parts of a system that adhere to the same strategy regarding customer experience. Testing whether or not a PSS is delivering synergetic value compared to the delivery of the separate components could be easily tested by using a Vickrey auction –as demonstrated in this paper. The benefit of a Vickrey auction, compared to, for example, customer surveys or a customer panel, is that real buyer behavior can be observed, rather than mere stated intentions.

As proposed in this paper, both product and service elements are important to how customers value the PSS. However, product-oriented producers that want to combine some of their products with services might lack sufficient capabilities and experience to develop and offer services that are valued by customers, as evidenced by this experiment. In a similar fashion, service-oriented producers may lack the necessary capability and experience to effectively develop the product-part of a PSS. Solutions for this problem include investing in the development of these capabilities or forming strategic alliances with complementary producers – which, in general is a more efficient solution. For example, producers could bypass downstream firms or eliminate upstream firms by forming alliances with producers in other positions in the value system.

Producers that extend their product or service portfolios with a PSS experiment with and exploit new business opportunities. This in turn requires that these producers adapt and renew their business models to achieve sustained value creation (Mason and Mouzas, 2012). Indeed, as suggested in prior literature (Baden-Fuller and Haefliger, 2013; Teece, 2010), business model choice plays an important moderating role in explaining how technological innovation affects corporate performance. A business model comprises the ‘architecture’ of how a producer creates, delivers, and captures value (Teece, 2010). Regarding business model elements, Baden-Fuller and Haefliger (2013) identify the following dimensions: customer identification, customer engagement, value chain linkages and monetization. Regarding customer engagement, for example, PSS’ can change the value proposition of a producer from delivering standardized, mass-production products towards more customization and tailor made solutions. Regarding value chain linkages, producers may need to go from a ‘hierarchy’ to a network structure (Mason and Mouzas, 2012), as
noted above, to build the necessary capabilities and resources for an effective PSS. Regarding monetization, producers could adopt a razor-blade model (Teece, 2010), in which pricing is done such that the service-part of the PSS subsidizes the product part. Furthermore, producers could adopt a payment system in which payment is done during or after use rather than upfront, as is common for products.

2.5.2 Limitations and future research

The empirical validation of this framework has some limitations. In the survey, product and service developers were only asked whether they agreed with the proposed ideas about the differences between products and services. Although they are the persons normally responsible for developing and designing the product or PSS, other types of employees such as marketing managers might also influence what will be developed and how it will be positioned. It would be interesting to examine if these marketing managers also agree with the proposed differences.

The second study only used one example of a PSS to measure how customers value a PSS and its separate elements. There are, however, many more and different types of PSS' available on the market. For example, Tukker (2004) discussed eight different types of PSS' that can be divided into three groups (i.e. product, use, and result oriented). Knowledge is required to determine the extent to which a given customer experience must be provided by the product-part, to what extent it must be provided by the service part of a PSS, and how this differs per PSS-type. In addition, future research could examine how customers value these different types of PSS' and how to best position the PSS so that customers see its superadditive value.

As PSS' are often offered through partnerships between multiple producers, future research could investigate which type of producer (for example the product or the service provider) is most suited to be the main ‘face’ on the market when selling the PSS. In other words, how the PSS should be branded. If it is branded using the names of all producers in the partnership or using a brand name that does not fit with the identity of the PSS, it might generate ambiguity in the eyes of customers. Therefore, knowledge is needed to determine how these partnerships should communicate the PSS, by taking their own brand equity into account.