

Designing Industrial Product-Service System (PSS) Pilot Projects in Manufacturing Companies: A Proposed Process for Product and Customer Selection

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Abstract

This paper proposes an approach for capital goods manufacturers to design Product-Service System (PSS) pilot projects by selecting appropriate products and customers. The authors conducted a single-case empirical study as a part of an ongoing action research project to maximise the learnings from a pilot project while minimising expenditure in extensive trial and error PSS solution testing. Two sets of criteria were elicited for product and customer selection, respectively, followed by a description of the ideal product and customer attributes for each of the three most common PSS archetypes.

Keywords: product-service systems (PSS), circular economy, empirical studies, customer selection, product selection

1. Introduction

A Product-Service System (PSS) is a marketable combination of products and services supported by the infrastructure and the network of actors, designed to deliver more value than traditional transactional offerings (Mont, 2002). When a PSS offering is developed around a product that has high net value in a business-to-business (B2B) context, it is also known as industrial or technical PSS (Meier *et al.*, 2011). Such offerings have the potential to decouple value creation from resource consumption within the circular economy (CE) paradigm, thus contributing to sustainability (Kjaer *et al.*, 2019). However, PSS solutions are not more sustainable than the traditional offerings by default (Frederiksen *et al.*, 2021).

Manufacturing companies embarking on the PSS development journey must strategically design the offering if they are to succeed in both fulfilling customer needs and contributing to sustainability improvements (Tukker, 2004). The early stages of PSS development play a vital role in the success of the whole offering (Rondini *et al.*, 2020), hence, this paper aims to contribute to early decisions in PSS design, within capital goods manufacturing companies. Specifically, the subject of this research is to understand how to select the most suitable product from a wide portfolio to elevate to the level of PSS, as well as how to select a suitable customer, with whom the new PSS solution should be piloted.

Few researchers have addressed the issue of customer segmentation specifically for PSS offerings (Vezzoli *et al.*, 2015), despite the recognised necessity to best identify and serve customer segments with limited company resources (Cooil *et al.*, 2007). Even fewer researchers have thus far tackled the issue of product selection for PSS elevation and piloting, hence the empirical nature of this research.

The main reason for such a meticulous inquiry into the pilot project design is the aspiration to execute the implementation of PSS offerings effectively and efficiently, in a way that could provide the steepest learning curve internally for the development of future PSS offerings, as well as the

smoothest collaboration possible with customers. Hence, the goal of a pilot project is not to rush for quick wins but to strategically explore opportunities that may lie ahead in an industry as a whole that is slowly but surely servitising its offerings (Reim *et al.*, 2019).

2. Methodology

2.1. Research questions

This research aims to investigate the characteristics influencing the PSS pilot project design from the product and customer selection viewpoints by answering the following research questions:

1. What are the relevant criteria and the process to select suitable products from the product portfolio for a pilot project in the development of industrial PSS offerings?
2. What are the relevant criteria and the process to select suitable customers for a pilot project in the development of industrial PSS offerings?

2.2. Data collection and analysis

The research was conducted according to the following steps:

1. The literature search was conducted with three search strings in the Scopus database. All the search strings contained synonyms of the keyword "product-service system" accompanied with the synonyms of keywords "pilot project", "customer segmentation", and "product selection". Less than half a dozen papers were discovered, none of which explicitly addressed the research questions. Since the literature yielded scarce information on answering the two questions, it was decided to collect the bulk of data through empirical research in an industrial setting.
2. The data collected were elicited through semi-structured exploratory interviews (Robson and McCartan, 2016) as a part of ongoing longitudinal action research (Coughlan and Coughlan, 2002) project in a single case company (Sarancic *et al.*, 2021). The focus on a single case study is considered a suitable approach since it deepens the research enquiry in a specific context, where the existing literature is lacking (Dyer and Wilkins, 1991). Five managers covering executive, commercial and technical, sales and aftersales positions from the case company were interviewed in the first round. The first round of interviews focused on the formulation of the selection process for customers and products.
3. Based on the first round of interviews, a workshop involving the five managers was held to consolidate the selection process based on the identification of emerging patterns (Yin, 2003).
4. The second round of interviews with the five managers was conducted as a new iteration and based on the previous findings. This round of interviews focused on the elicitation of product and customer selection criteria, which is the first step of the proposed selection process.
5. The rest of the proposed process was performed with continuous interaction and feedback from the involved managers over two months.
6. A follow-up session involving the five managers and PSS development experts was organised to consolidate and validate the selected customers and products for the PSS pilot project.

2.3. Case company

The empirical setting for this research was a capital goods manufacturing firm focused on the manufacture of food production machinery and equipment. At the time of writing, the firm was in the exploratory phase of the development of PSS offerings as a means to contribute to its triple-bottom-line (TBL) (Elkington, 1998) sustainability-oriented strategy. Already at an initial stage of development, while exploring the opportunities within own product portfolio and sensing the customer interest, a lack of academic insight into selecting the direction of a pilot project was observed.

Having a vast palette of product offerings, identification of the most suitable product (range) from the product portfolio to utilise for a PSS pilot project posed itself challenging. A similar challenge appeared when trying to select a customer (segment), with whom the pilot solution could be co-developed. Both challenges arose due to the large variance in products' and customers' characteristics.

3. Results

Despite the need to segment customers and products from a PSS provider perspective, very few authors have addressed this gap in the literature (Vezzoli et al., 2015). The importance of the task stems from limited company resources to be dedicated to pilot projects (Cooil et al., 2007). Unlike in the traditional product sales arena, grouping customers based only on their revenue generated or geographical location is no longer enough (Bailey et al., 2010). More specific criteria can enable new, more customer-focused value propositions (Adrodegari et al., 2018), as not all customers will be suitable PSS customers, nor does one PSS type fit all (Windler et al., 2017).

The posed research questions are most commonly approached in the literature from customers' viewpoints and needs through the "voice of the user" (Pezzotta et al., 2018), but the perspective is missing concerning the "voice of the provider", i.e. the strategic decisions for the customer and product selection that promise the most lucrative future business. Kim et al. (2006) propose a framework for customer segmentation based on customer lifetime value which includes current value, potential value and customer loyalty. However, more detailed criteria and operational procedures are missing in the literature both for the customer and even more so the product selection for PSS offerings.

Section 3.1 addresses the developed processes to select the most viable customers and products for industrial PSS pilot projects, while the following two sections address important criteria to consider at the beginning of the proposed selection processes.

3.1. Proposed selection processes

As an answer to the research questions, two slightly different processes for the selection were proposed, based on empirical research. They differ only in one extra step necessary for customer selection. The proposed process is presented in Figure 1.

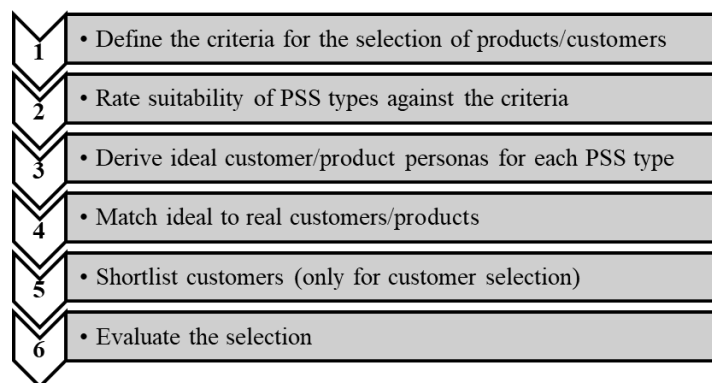


Figure 1. The proposed selection process for the product and customer selection

The first step concerns elicitation of the relevant criteria that influence the selection of a given product or a customer. The criteria can assume different values (e.g., low or high sales volume) and those differences are deemed to influence the selection of the PSS pilot project initiatives.

Another aspect relevant for the selection is the different PSS types, namely product-oriented, use-oriented, and result-oriented, as defined by Tukker (2004). Product-oriented PSS is geared towards the sales of products with added services, such as advice or maintenance. Unlike the product-oriented PSS, use- and result-oriented PSS are characterised by product ownership retention by the provider. Examples of use-oriented PSS are renting, sharing, and leasing, while in the result-oriented PSS, the customer and the provider agree on a result with no pre-defined product specified. The three types have different impacts on sustainability, where the result-oriented PSS has the highest sustainability potential, but sustainability benefits in any PSS solution (Frederiksen et al., 2021). It is considered that the PSS type has a large influence on determining the suitability of different products to be a part of the total solution (Chiu et al., 2015), as well as the customer to whom the solution is offered (Windler et al., 2017).

The goal of the second step is to map the suitability of the three PSS types with different values that criteria can assume. The outcome of this step is an overview of the criteria's influence on the selection of a particular PSS type. This overview is used to be able to derive the "ideal" product and a customer

for each of the PSS types in the next step. The mapping was completed by the authors and the suitability was ranked on a scale from 1 to 3, where 3 indicates the highest suitability. The suitability was determined for each of the criteria by envisioning the scenarios in which the criteria assume different values for different PSS types. Then, a judgment was made of the influence of different criteria values on the different PSS types based on foreseeable barriers should a given scenario be selected. Scenario-based judgment was adopted as it is considered that thinking in terms of scenarios ensures a systemic approach (Maussang *et al.*, 2009). The scoring procedure is further exemplified in Section 3.

The scores from the second step were then derived and consolidated to create a description of an ideal product or customer description for each of the PSS types in Step 3. All the criteria for which a given PSS type was scored as very suitable (score of 3) were adopted as ideal product or customer attributes. Steps 1-3 are elaborated in more detail in the following sections, while Steps 4-6 are company dependent and should be adjusted to fit different organisational structures to finish the selection process. The exact product selected in the case study is not revealed here, due to confidentiality issues. The following describes some general guidelines for Steps 4-6:

- In Step 4, it is best to involve the head of product management to identify the product that matches the "ideal product" or "ideal customer" characteristics. An ideal product or customer is a fictional construct, an abstraction of entities with similar characteristics that represent the typical product or the customer for a given PSS type (Fergnani, 2019). This step may yield multiple products and customers fitting the criteria.
- In Step 5, to shortlist customers, it might be required to conduct more in-depth screening of previously listed customers with the sales representatives responsible for them to gauge which customers would be more willing to co-operate.
- In Step 6, the selected criteria and consequently products and customers are to be validated in a workshop where all the interviewees should be present, together with PSS development experts.

3.2. Product selection

This section presents the authors' proposal of relevant criteria to consider when selecting a product (range) from a product portfolio for the piloting of PSS solutions.

Step 1 in the product selection process

Table 1 addresses the first step listed in Figure 1 for the product selection.

Table 1. The first step in the process of product selection for the PSS pilot project

Criteria for product selection (20)	Description	Proposed unit of measurement
<i>Sales volume</i>	Lower sales volume might not justify the investment in the supporting infrastructure	Number of sold items
<i>Price</i>	It might be difficult for the provider to afford to retain ownership of the product	Monetary value
<i>Complexity</i>	Higher complexity often makes it challenging to guarantee outcomes	Number of parts and connections between them
<i>Reliability</i>	Fewer unexpected events mitigate the risk	Number of failures over time
<i>Criticality for customers' operations</i>	Guaranteed performance is often required when many subsequent operations depend on that product	Number of processes depending on that product
<i>Dimensions</i>	Product size might seriously impact logistics	Length × width × height
<i>Suitability for diverse customer segments</i>	Risk is mitigated if a product is offered to many customer segments	Number of customer segments
<i>Newness in the market</i>	The newer the product, the less experience the provider has with its operation	Time in market
<i>Upkeep cost size and variability</i>	If service costs are high and/or variable the provider might be reluctant to become responsible for them	The price of service

Product energy and water use efficiency	More efficient products are better for the environment	Watt [W], litre [l]
Level of digitalization	Digitized products enable remote service	See e.g. Siedler et al. (2021)
Level of product standardization	Standardization generally leads to easier service	% of standard parts
Knowledge of customer usage patterns	The better the provider knows how customers use the product; the easier will be to upkeep it	Subjective measure
Time spent by customer service on that product	Customers might not be aware of all the support they get for a particular product	Hours spent on support
Learning potential	The whole product portfolio might benefit from the learnings obtained from a single product	Number of solutions the product is a part of
Scalability potential	An already existing installed product base and/or high forecasted product demand influence scalability potential	Number of installed products, demand forecast
Supply chain complexity	Less complex and more predictable demand enable risk mitigation	Number of suppliers
Flexibility	The product's ability to match the variability in production capacity can be highly regarded	Range of product operating capacities
Installation complexity	The less complex installation allows for a quicker product take-back and the next commissioning	Time to install
Empowerment Potential	Assistance in the provision of income-generating activities for underserved	Subjective measure

Step 2 in the product selection process

In this step, the scoring of the suitability of product selection criteria assuming different values for the different PSS types is demonstrated on the example of the case company. Table 2 showcases scores for three examples of the criteria scoring for the case company.

Table 2. The suitability of the three PSS types with different values that product criteria can assume

Criteria for product selection	Description	Criterion value	Suitability of PSS types with different values of criteria		
			Product-oriented	Use-oriented	Result-oriented
Sales volume	Lower sales volume might not justify the needed investment in the supporting infrastructure	low	3	1	1
		high	1	3	3
Price	The provider may have difficulties affording ownership retention	low	1	2	3
		high	3	1	1
Complexity	Higher complexity often makes it challenging to guarantee outcomes	low	2	3	3
		high	2	1	1

The scores for the three examples in Table 2 may be interpreted as follows:

- A high sales volume is ranked as very suitable (score of 3) for the use- and result-oriented PSS types and less suitable for the product-oriented (score of 1). These scorings are assumed because it is likely that it is economically unfeasible to develop and upkeep the needed infrastructure to support the services such as leasing or guaranteed performance if only a few of those products are in demand on the market.
- The price of a given asset in a great measure determines the PSS provider's financial ability to grant customers access over ownership. A higher upfront cost of an asset makes the provider reluctant to go for use- or result-oriented PSS types.

- The complexity of a capital good could likely influence the PSS provider's confidence in the product's operation, hence making them disinclined to commit to extended product responsibility. Therefore, a guarantee of a specific machine's uptime or performance as in the use- or result-oriented PSS types is a challenging endeavour in a pilot project.

Step 3 in the product selection process

Table 3 shows ideal product descriptions for the three PSS types from the PSS provider perspective.

Table 3. Ideal product characteristics for each of the PSS types

Product-oriented	Use-oriented	Result-oriented
<ul style="list-style-type: none"> - lower sales volume - higher price - lower reliability - lower criticality - larger dimensions - suitable for few segments - higher & variable upkeep cost - less customer service time spent - lower scalability potential - more complex supply chain - lower empowerment potential 	<ul style="list-style-type: none"> - higher sales volume - lower complexity - higher reliability - smaller dimensions - suitable for more segments - older product in the market - more efficient - more standardised - higher learning potential - less complex supply chain - more flexible - shorter installation - higher empowerment potential 	<ul style="list-style-type: none"> - higher sales volume - lower price - lower complexity - higher reliability - higher criticality - smaller dimensions - suitable for more segments - older in the market - lower & uniform upkeep cost - more efficient - highly digitised - more standardised - knowledge of usage patterns - customer service time spent - higher learning potential - higher scalability potential - less complex supply chain - more flexible - shorter installation - higher empowerment potential

3.3. Customer selection

This section aims to showcase relevant criteria for customer segmentation for PSS offerings and ultimately the selection of exact customers to start piloting with and to cover all PSS types.

Step 1 in the customer selection process

Table 4 addresses the first step listed in Figure 1 for the product selection.

Table 4. The first step in the process of customer selection for the PSS pilot project

Criteria for customer selection (13)	Description	Proposed unit of measurement
<i>Customer's company size</i>	Companies of different sizes have different challenges and motives for PSS adoption	Number of employees, turnover
<i>Customer newness</i>	Older customers might have difficulties switching to new business models	Time in relation with the customer
<i>Customer's purchasing variety</i>	If the customer buys many product types, a likelihood is that they will want to help with some of the types	Number of product types
<i>Customer's industry experience</i>	Experienced customers might not need services from the provider because they can resolve the issues themselves	Years in market
<i>Customer's location</i>	The customer's distance to the provider might influence the profitability and sustainability of the PSS offering	Distance to customer
<i>Trust</i>	The trust that customers will use the product responsibly influences PSS type selection	Subjective measure

<i>Customers' willingness to share data</i>	It is unlikely that use- or result-oriented PSS can be established without access to use data	% of data points willing to share
<i>Customer's production capacity and seasonality</i>	Depending on the size and variance of customers' production capacity, different PSS types may be suitable	Production volume over time
<i>Customer's financial situation</i>	Customer's buying power determines the PSS type they can afford	Credit rating
<i>Customer's level of digitalisation</i>	Customers that are more used to IT might be more likely to continue using it for performance monitoring	As defined, e.g., by (Colli <i>et al.</i> , 2019)
<i>Customer's sustainability focus</i>	Customers whose strategies are focused on sustainability might value access models more than ownership models	Subjective measure
<i>Familiarity with TCO and recurring payment</i>	If customers had previous experience with similar models, that might make them more likely to opt for PSS offerings	Subjective measure
<i>Customer's historic demand for service</i>	If customers have many service needs, that might prompt them to opt for guaranteed performance models	Number of service interactions over time

Step 2 in the customer selection process

In this step, the scoring of the suitability of customer selection criteria assuming different values for the different PSS types is shown on the example of the case company. Table 5 showcases scores for three examples of the criteria scoring for the case company.

Table 5. The suitability of the three PSS types with different values that customer criteria can assume

Criteria for customer selection	Description	Criterion value	Suitability of PSS types with different values of the criteria		
			Product-oriented	Use-oriented	Result-oriented
<i>Customer's company size</i>	Companies of different sizes have different challenges and motives for PSS adoption	small	1	3	3
		big	3	2	2
<i>Customer newness</i>	Older customers might have difficulties switching to new business models	new	1	3	3
		old	3	2	2
<i>Customer's purchasing variety</i>	If the customer buys many product types, a likelihood is that they will want to help with some of the types	low	3	2	2
		high	1	3	3

The scores for the three examples in Table 2 may be interpreted as follows:

- Smaller customers in terms of buying power might not be able to afford to pay for the ownership of an asset up-front, as in the product-oriented PSS. Therefore, the ability to extend the payment period through recurring payments is a very appealing value proposition for them. That value proposition is not that relevant for the larger customers, as they can afford up-front payments in most cases. When that is combined with their usually already established network of service technicians to oversee the machine operation, they tend to stick with the old, product-oriented model. However, some larger customers are willing to reconsider the current setup and pay more if the offering has more sustainability potential, as in the case of the result-oriented PSS.
- It is challenging for a customer to change the way they function, especially if the same pattern of collaboration between the provider and the customer was present for several years. Therefore, it is considered that the newer players would be more willing to start the collaboration from scratch with PSS types with more service content, such as result-oriented PSS. This argument is

even stronger if the customer is new in the industry and lacks operation experience. Such customers are deemed even more inclined to receive knowledge and services from the provider.

- When a customer is operating many types of machines, it is considered that such customers would be more enthusiastic to outsource the operation of machines that are not their core business. On the other hand, a customer that is very specialised and is using only a few types of machines would be likely to want to stay in full control of them.

Step 3 in the customer selection process

Table 6 presents a description of ideal customer attributes for each of the PSS types.

Table 6. Ideal customer characteristics for each of the types

Product-oriented	Use-oriented	Result-oriented
<ul style="list-style-type: none"> - bigger company - old customer - lower purchasing variety - high industry experience - farther from the provider - lower trust - unwilling to share data - lower digital capabilities - less focus on sustainability - less familiar with recurring payments 	<ul style="list-style-type: none"> - smaller company - newer customer - higher purchasing variety - closer to the provider - higher trust - willing to share data - worse financial situation - better digital capabilities - familiar with recurring payments 	<ul style="list-style-type: none"> - smaller company - newer customer - higher purchasing variety - lower industry experience - closer to the provider - higher trust - willing to share data - high capacity/seasonal use - worse financial situation - better digital capabilities - focus on sustainability - familiar with recurring payment - high historic service demand

4. Discussion

Segmenting and selecting products and customers are challenging tasks, even more pronounced when focused on complex offerings that are product-service systems, rather than just products, and in an uncertain environment where a new solution is offered for the first time through a pilot project. This complexity emerges from numerous factors, including but not limited to (i) the larger number of customer touchpoints over a longer-lasting relationship (touching upon criteria such as e.g. trust or willingness to share data), (ii) scope of delivery (touching upon criteria such as product, installation and supply chain complexity), (iii) increased logistics operation due to service (criteria related to customer's location or product's reliability), and (iv) more complex pricing and finance processing solutions (criteria e.g. product price, customer's familiarity with TCO) in PSS than in pure product sales.

This article aimed to propose an empirically developed process and elicited criteria that influence a strategic decision on how to pilot PSS solutions, and to thus harness a piece of PSS pilot project complexity and uncertainty. The feedback received from the case company was that the process and the criteria as elicited were of great help to narrow down the focus of the PSS development process.

In practice, however, the process may be conducted in an altered sequence of steps. A practitioner might find it expeditious to assign attributes to the real products in the product portfolio or the real customer, and then match them with the ideal attributes listed in the above section. Furthermore, the proposed process should be tested in more cases, to verify and validate the steps presented.

It is important to note that the provider's perspective is taken when discussing both product and customer selection and that the scope is limited to PSS pilot project considerations. Many contradictions may thus arise, between the criteria that a customer would prioritise to buy a PSS offering and the criteria the PSS provider would prioritise to offer a PSS offering. A PSS provider will not want to take the responsibility for the service of a product if service costs are high and variable; on the other hand, the customer wants exactly that - to eliminate as much risk as possible. Another example is that the customer might want to procure PSS solutions for the most capital intensive and complex product, which might not be the best

place for the provider to start, as the provider might not be able to guarantee the outcome of a PSS upfront. Therefore, the case company opted for a less risky option of starting the PSS journey with cheaper and less complex products and building the capabilities along the way. A balance should be found between the product offered as a part of a PSS and the customer that it is being offered to in terms of value delivered to the customer and the enablement of a steep learning curve for the provider.

Largely, similar ideal customer and products attributes can be seen between the use- and result-oriented PSS types, while the product-oriented PSS ideal attributes differ from the other two types. The empirical insights suggest that the differentiating criteria lay in the customers' purchasing power, i.e. the price of the stand-alone product, the environmental sustainability potential of the PSS solution, and the customer relationship, i.e. willingness to share data and knowledge of the usage patterns. Larger companies might be willing to pay more for outsourced operations or more sustainable solutions, while smaller companies opt for PSS, due to reduced upfront costs and are not as concerned about sharing data.

The selection of the most promising PSS pilot project options is a multi-faceted and highly context-dependent problem, which is why individual practitioners must further tailor the proposed process and the criteria. Once selected, the pilot project introduces certain boundaries in the following development process, thus limiting future design options. The decisions made in this early design stage will determine both the provider's and the customer's TBL of sustainability, which the case company intended to address with PSS offerings in the first place.

Verification of criteria used to select the pilot project can be conducted after the launch of the pilot project. The pilot project success can be brought in relation to how close were the selected product and the customer to the ideal, as defined by the elicited criteria.

5. Conclusion

Getting the most out of a PSS pilot project in an industrial setting as a manufacturer depends on a series of considerations. The starting point in the design of PSS offerings might influence the adoption of further solutions by the customers to a great extent. Therefore, an elaborate procedure and two sets of criteria for the selection of the product from the product portfolio and a customer to approach with the new offering are presented, respectively.

Twenty products and thirteen customer criteria to consider while designing pilot PSS offerings have been elicited through a series of semi-structured exploratory interviews, within a capital goods manufacturing company. Each criterion's values have then been rated, according to the suitability for the three PSS types. This has been carried out to obtain descriptions of an ideal product to start developing into PSS solutions, and ideal customers to start offering the solution to.

Limitations

The described processes and the criteria for the selection are based on a single case study, hence, they have a unique application. Therefore, it is not possible to draw conclusions applicable to all manufacturing companies. Nevertheless, the usefulness of the study is showcased in the depth of insight for an individual practitioner, that was not present in the literature at the time of writing.

Acknowledgement

In addition to the case company, the authors would like to acknowledge the support of MADE – Manufacturing Academy of Denmark.

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