

Product-Service Systems across Life Cycle

Framework for Analyzing Customer Involvement in Product-Service Systems

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Abstract

In manufacturing, product-service systems (PSS) that create value by coupling a physical product and a service have been attracting attention. In PSS, it is important for providers to enhance the value-in-use that is perceived by customers in utilizing a product and/or service. Customers play a key role in realizing such value and therefore, are regarded as co-producers in the value-creation process. Although customer involvement plays an essential role in realizing value, previous research has revealed its risks. Therefore, PSS providers are required to adopt a suitable strategy for involving customers. However, current studies do not necessarily offer much guidance on determining such strategies. To solve this problem, this paper proposes a framework that analyzes the benefits and risks of customer involvement in PSS development. This framework aims to identify factors that influence benefits and risks from the viewpoints of characteristics of a PSS and its customer involvement. The effectiveness of the proposed framework is validated through a case study.

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1. Introduction

At present, because of the cheap labor in certain countries, many companies are struggling to turn a profit and compete with other firms that sell products of the same quality at lower prices. It therefore has become difficult for many manufacturers to increase their profits by only selling products [1]. Because of this predicament, product-service systems (PSSs) [2-4] have begun to attract attention as an option for income generation.

In PSS, it is important for providers to enhance the value-in-use that is perceived by customers in utilizing a product and/or service [2]. Customers play a key role in realizing such value. For example, early involvement with customers is essential for the creation of a better solution that responds to customers' requirements. It is also important for providers to involve customers in the delivery of a PSS because they play an important role in giving productive feedback and facilitating

continuous improvement. In PSSs, therefore, customers are regarded as co-producers in the value creation process. Many researchers have conducted research on how to involve customers in product or service development. Previous studies have revealed various types of involvement. For example, Hoyer classified customer involvement in the scope of co-creation activities as well as their intensity [5]. Customer involvement provides benefits for both customers and providers, such as improving productivity and quality. However, many researchers have pointed out the potential of increasing risk. For example, Hoyer stated that customer involvement increased the complexity of managing the objectives and interests of diverse stakeholders [5]. In PSS, customers could be involved in not only product development but also service development. These kinds of customer involvement could result in increasing potential benefits as well as potential risks, which are influenced by the characteristics of PSSs, such as the type of provider, market,

and core product. A certain type of customer involvement could increase benefits and vice versa. In other words, customer involvement is not always effective in PSS development. Therefore, providers need to adopt a suitable strategy for customer involvement by considering the characteristics of PSSs. While many researchers emphasized the importance of customer involvement in PSSs [2, 6, 7], current studies do not necessarily offer much guidance on determining such strategies.

To solve this problem, the objective of this study is to reveal the benefits and risks of customer involvement in PSS development. Especially, we aim to reveal mutual influence of product and service type on customer involvement in PSSs. A qualitative methodology has been performed to conduct this research, which is still at its preliminary phase. The research methodology is discussed in the next session in general terms, than specified in dedicated paragraphs as follow. First, a literature review is conducted to specify the perspectives that characterize customer involvement as well as its potential benefits and risks. Based on the results of the literature review, a conceptual framework is proposed to analyze the benefits and risks of customer involvement in PSS development. Subsequently, by taking into account the characteristics of PSSs, a case study protocol has been developed to understand how the proposed framework could reveal the relationship between the type of customer involvement and its benefits and risks. At the moment the study has been conducted in a selected case study. Finally, based on the results of the case study, a strategy for customer involvement in PSS development is discussed and will open the door to a deeper qualitative analysis that will involve a higher number of companies with the objective to improve, validate and generalize the proposed framework.

2. Research Methodology

The research conducted within this paper is qualitative research that aims at proposing a conceptual framework able to describe customer involvement strategies within enterprises involved in PSS development. The ultimate purpose, as a future research, is to develop a framework able to guide companies in the selection of the proper customer involvement strategy when developing PSSs. Given the relatively novelty of the topic and the lack of similar contribution in literature, the authors decided to start their investigation with a qualitative analysis. In the specific literature review is considered as a starting point for the conceptual framework development.

The main steps followed in this research are *plan, design, preparation, collection, and analysis* [8]. First research objectives and rational have been identified, as shared in the introduction (*plan*). Secondly (*design*), the research has been detailed designed into a conceptual framework (see Section 4) derived by the literature review (see Section 3). In the *preparation* phase a protocol case study has been outlined, based on the proposed framework, with the objective to be used as a reference structure for the upcoming interviews, in the form of semi-structured interviews. The purpose is to collect data from different enterprises, dealing with different kind of PSSs, to make the framework comprehensive and general.

However this research present a unique case study, used as a pilot case for the framework evaluation (*collection*). The company chosen for the analysis is representative of a certain typology of PSS, and the authors decided to choose such a case study because of the specific sector (printing machines) where the concept of PSS is prevalent since many years (see Section 5). Since the interview is quite in depth and the main objective of the research is to collect different cases (more companies operating with different PSS typologies) the choice is to interview one representative for each company, carefully chosen for his/her knowledge on both the PSS development and customer integration.

After the interview data have been analyzed (*analysis*) with a content analysis, in order to track the framework categories identified in literature, though an inductive content analysis [9, 10]. Furthermore news insights derived from the interview. This gave indications on the framework goodness and completeness.

3. Literature review

3.1. Strategy for searching and selecting articles

Relevant papers were identified using a combination of the databases: web of science, Scencedirect and Google Scholar. First, these paper were searched by using the key words: customer involvement, customer integration and co-creation. Subsequently, we narrowed down these papers with the key words: product development, service development and Product-Service Systems. As a result 73 articles were identified. Their titles and abstracts were reviewed by one author for relevance to this study. Papers were included if they contained perspectives for characterizing customer involvement or revealed benefits and risks of customer involvement.

3.2. Perspectives for characterizing customer involvement

Hoyer et al. proposed a comprehensive framework to represent consumer co-creation in the new product development [5]. This framework includes topics that are discussed in consumer co-creation. Using this framework, they defined the degree of co-creation, as the function of both the scope of co-creation activities and the intensity of these activities. The scope of co-creation refers to the propensity of firms to collaborate with consumers across all stages of product development. Intensity of co-creation refers to the extent to which firms rely on co-creation in a particular stage of product development. Kaulio proposed a framework for analyzing methods of customer involvement in product development [11]. The framework includes two dimensions of involvement: longitudinal and lateral. The longitudinal dimension refers to the points of interaction between customers and the design process, such as the specification phase, concept development, and prototyping. The lateral dimension, in contrast, determines how deeply customers are engaged in the design process. In order to describe this dimension, the categories “design for,” “design with,” and “design by” are used. O’Hern and Rindfleisch presented a conceptual typology of four different types of co-creation activity based on the two dimensions [12]:

1) the contributions of customers either are fixed by a firm or are wholly open to customer input; 2) the selection of these contributions is either directed by a firm or directed by customers. Cui and Wu proposed three forms of customer involvement in innovation: customer involvement as an information source, customer involvement as co-developer, and customer involvement as innovators. According to these forms, they analyzed factors that drive utilizing customer knowledge and influences on product performance [13]. Lynch et al. identified set of metrics to measure the involvement of a network of customers. The metrics consisted of (1) the reasons for involving a network of customers, (2) the structure of the customer network involved, and (3) the process of customer involvement. Especially, the structure was presented from the viewpoints of type and size of customers involved, and timing and duration of customer involvement. On the other hand, the process were analyzed from the viewpoints of frequency, responsibility and intensity of interaction [14].

3.3. Benefits and risks of customer involvement

Several previous studies have revealed the benefits and risks of customer involvement. Customer involvement provides many benefits through the product/service development process. Customer involvement increases productivity and efficiency gains through cost-minimization because employees' input can be substituted by consumers' input in the development of products and services [5]. For example, customer involvement enables the provision of new ideas for design, engineering, manufacturing [15], and the outsourcing of development tasks to customers. This situation leads to the decreased need for input from employees and traditional market research [5]. Furthermore, continual customer feedback during development enhances the efficiency of development, thereby minimizing last-minute changes, realizing faster speed-to-market, reducing cycle time and inventory obsolescence [16, 17]. As a result, companies take an advantage in the effectiveness of their response to market demands [18].

From their experiences in customer involvement, providers can learn more about customers' aspirations, desires, motivations, behaviors, and agreeable trade-offs regarding features and functions [15]. Learning more about customers allows for the closer fit of products and services to consumer needs, higher perceived quality/novelty, and lower risk of failure. Through customer integration, firms will penetrate deep into the customer organization to understand its product, culture, market and organization in such a way that they can respond precisely to the customer's needs and requirements. [17] Dong et al. stated that consumer involvement might empower consumers to respond to a product or service failure in a manner that would abate the negative outcomes of the failure [19]. Consequently, consumer involvement would realize savings on customer education and other support activities [5]. Furthermore, a closer fit with the preferences for co-created product/services could encourage positive attitudes toward the product, subsequent purchase intentions, willingness-to-pay, and referrals by word of mouth [5]. With regard to the service delivery process, customer involvement

would also influence organizational performance, such as the efficiency of operations and employee satisfaction [20].

However, several studies also clarified the costs and risks in customer involvement. A major challenge of co-creation is the diminished control over a firm's strategic management and planning. In addition to decreasing control, the empowerment of consumers increases the complexity of managing a firm's objectives and the interests of diverse stakeholders, such as employees, shareholders, co-creators, and other types of consumers [5]. Hoyer stated that having close relations with too many customers would increase the complexities of not only managing customers' expectations and relationships but also selecting customers' ideas [5]. Song et al. pointed out organization risks, such as customer conflict, partner selection misunderstanding between employee and users [21].

Moreover, development processes that are co-managed by customers increase the amount of uncertainty for the provider. The misperformance sometimes results from the consumer's lack of the required skills, such as the inability to express their needs and wishes or to articulate their ideas [21, 22]. Furthermore, when customers are integrated into the development process, they are likely to acquire the provider's expertise while contributing their own knowledge or ideas. The obvious risk of customer involvement is that they could use the expertise for their own purposes, such as selling it to a competitor [22]. Enkel et al. also pointed out the risk of intellectual property [22]. The provider may feel that all ideas generated during the development process are the provider's property, but unless this was agreed upon beforehand, customers could claim a joint, or even full, ownership of the ideas [22].

Enkel et al. stated that the failure to choose the "right" customers would lead to preventing innovative ideas because customers would expect a personal benefit [22]. If the customers involved in the development process represented only a small group, such as a niche market, the provider's expectations regarding sales and profit might not be met. Furthermore, Enkel et al. also pointed out that relying on customers' experiences would prevent radical innovations and encourage only incremental ones [22].

Moreover, typical employee appraisal procedures are not likely to apply because consumers are not under the direct control of firms [5].

4. Framework for analyzing customer involvement

Based on the results of literature review, the proposed framework consists of three perspectives: *general information*, *customer involvement features*, and *benefits/risks*. This framework aims to identify factors that influence benefits and risks from the viewpoints of general information and customer involvement features. General information includes items that characterize a PSS, such as products, services and customer segments. Customer involvement features represents configuration in involving customers. Details of each perspective are as follows.

As shown in Table 1, customer involvement features include four items: scope, intensity, selection, and contribution. Scope refers to the propensity of the provider to involve consumers

across all stages of PSS development. In PSS development, customer's activities are part of the value-creation process, and the provider must interact closely with the customer throughout this process [23]. In this study, therefore, the stages of PSS development include not only the product life cycle but also the customer relationship life cycle in the relationship between the provider and customers. For example, the product life cycle consists of idea generation, design, production, testing, installation, use, maintenance, and so on; the customer relationship life cycle includes access, diagnosis, delivery, follow-up, and so on.

Intensity refers to how deeply customers are involved in the development process. To describe this item, this study extends the concept of the lateral dimension proposed in [11]. Intensity is described according to "X for customers," "X with customers," and "X by customers," in which X represents a stage in PSS development, which is mentioned above. For example, if customers are involved in the production stage, its intensity is represented as "production for customers," "production with customers," and "production by customers." Furthermore, in "X for customers," customers have no involvement. "Production for customers" means that the product or service is produced by the provider for customers. "X with customers" corresponds to the interactive approach between the provider and customers, and "production with customers" refers to the customers' participation in the production, such as mass customization. The stage "X by customers" mainly relies on the customers; "production by customers" indicates that the customers mainly produce the product or service, such as "do-it-yourself" (DIY).

Furthermore, if a stage in PSS development is conducted with customers or by customers, customer involvement is characterized by selection and contribution. According to the definitions in [12], the contributions of customers are either fixed by the provider or wholly open to customers; the selection of these contributions is either directed by the provider or directed by customers.

According to the results of the literature review, the benefits and risks in customer involvement are as follows. As shown in Table 2, the benefits include productivity and efficiency, product quality, and customer relationship. As shown in Table 3, on the other hand, the risks consist of management, customer capability, intellectual property, innovation, and internal organization.

Furthermore, these benefits and risks are also influenced by the characteristics of PSSs. The general information perspective, therefore, describes relevant characteristics that potentially influence the benefits and risks. These characteristics include the type of product/service, the business model, and the type of customers.

Table 1. Perspectives that characterize customer involvement.

Characteristics	Descriptions	References
Scope	Stages of PSS development where customers are involved	[5], [11]
Intensity	How deeply customers are involved in the development process	[5], [11], [13]
Contribution	Contributions of customers are either fixed by the provider or wholly open to customers	[12]
Selection	Selection of contributions is either directed by the provider or directed by customers	[12]

Table 2. Benefits in customer involvement.

Benefits	Examples	References
Productivity and efficiency	- Minimizing last-minute changes	[5], [16],
	- Realizing faster speed-to-market and reducing cycle time	[17], [18], [20]
Product quality	- Acquiring new ideas for design, engineering, and manufacturing	[5], [15],
	- Ensuring that products and services have lower risks of failure	[19]
Customer relationship	- Encouraging positive attitudes toward the product, subsequent purchase intentions, willingness-to-pay, and referrals by word of mouth	[5], [19]

Table 3. Risks in customer involvement.

Risks	Examples	References
Management	- Increasing management complexity	[5]
Customer capability	- Consumer's lack of required skills	[22], [21]
Intellectual property	- Leaking and theft of intellectual property	[22]
Innovation	- Preventing radical innovation	[22]
Internal organization	- Mismatching employee appraisals	[5]

5. Case study

5.1. Overview

The selected case study for this phase of research is a worldwide company operating in the industrial printing machines manufacturing sector, whose name has kept anonymous at this first phase of the research. The choice of this sector is given to the high attention historically provided by this sector for being a precursor example of PSS (e.g. the very popular Xerox case [2]).

The interview, following the approach of qualitative empirical research, has been structured according to a semi-structure outline, defined in a form of protocol. Such case study protocol will be used to populate the data coming from the field, through a higher number of companies interviewed.

This case study served as a pilot case for a first framework evaluation and the protocol. One person was interviewed in the company: a Lean Program Manager. He works in Israel. He has been working in the company since 2012. He is responsible for leading and facilitating global and Local Lean transformations, Operational Excellence projects and Value Stream Improvements, in both Manufacturing and Services areas.

The interview was recorded, transcribed, and analyzed with inductive content analysis [9, 10]. The results of the interview is summarized in the following sections.

5.2. General information

With regard to product and service, the company sells standard printers that are not customized to suit customer segments. Some options are provided, such as a range of colors, special effects, and applications such as raised printing effects. The company's distributors sell the product and offer support, such as installation, directly to customers. Furthermore, they also provide solutions for improving the production workflow of customers. Their business model focuses on developing, producing, and selling printers as well as leasing printers. The

leasing business earns money by customers’ printings, such as impressions of the press. Customer segments include both commercial and industrial markets. The industrial market includes several customer segments, such as labelling and packaging. The company has long-term relationships with most of its customers. In this case study, we focused on printer selling business to industrial markets.

5.3. Customer involvement

Table 4 shows characteristics of customer involvement revealed in the case study. With regard to customer involvement in PSS development, first, the scope of customer involvement was identified, including design and production, test, use, maintenance, learning, and process improvement.

The manufacturer conducts design and production based on the feedback obtained from customers. This feedback is collected in various ways. For example, before developing the next product, marketing and engineering employees visit customers to understand their needs. However, customers are largely involved in the testing stage. In this stage, the beta version of products is provided for customers to test, use, and provide feedback. The company also has laboratory for testing the products. Customer contributions to testing are restricted to using the product and providing feedback; the selection of such contributions is completely directed by the manufacturer.

Although the use of products mainly relies on customers, the manufacturer sends engineering experts to support customers at their most critical times during the year, such as holidays. Furthermore, when customers have technical problems that they cannot solve, the manufacturer alerts employees in production, engineering, R&D, and service organizations to support the customers in technical problem solving onsite as well as online. In this stage, customer contributions are relatively restricted, such as asking the manufacture for

support. However, the customers lead the selection of this contribution because they can ask for support at any time. Although the customers mainly conduct maintenance, the manufacturer offers some support. Although guidelines for standard maintenance are provided, customers are responsible for implementing them. The manufacturer provides consultation about do conduct maintenance correctly, and it supports customers’ problem solving by sending service staffs to the regions. Furthermore, the manufacturer has training centers around the world to support its customers. However, the maintenance itself is being done by customers. Therefore, customer contributions to maintenance are strictly controlled by the manufacturer. However, the selection of this contribution is directed by the customers, because they can receive consulting and education about the product.

The manufacturer provides solutions for improving the production workflow of customers. In the process improvement stage, it monitors operations in order to improve the operation of the press. In this stage, contributions are open to customers because they can either develop solutions or wait for solutions provided by the manufacture. The selection of this contribution is open to customers because they can decide if they need a solution to improve workflow.

5.4. Benefit and risks

The bottom line in Table 4 shows benefits and risks revealed by the case study. The customers mainly conduct the maintenance because it is impossible for the manufacturer to have sufficient resources to fix all the problems they encounter. Therefore, although the manufacturer invests in call centers and education centers for customer training, it also utilizes the resources of customers by encouraging them maintain the product. This involvement results in the increased productivity and efficiency of the maintenance of the product.

Table 4. Characteristics of customer involvement revealed in the case study

Scope	Product lifecycle				Customer relationship lifecycle	
	Design and production	Test	Use	Maintenance	Learning	Process improvement
	Mainly conducted by the manufacturer based on feedback from customers					
Intensity	For customers					
	With customers	Products in the beta version are provided to customers to test	Mainly relies on customers, while the manufacturer provides some supports	Mainly conducted by customers, and the manufacture offers some support	Receive education provided by the manufacturer	Providing solutions for improving the production workflow
	By customers					
Contribution	Fixed by the provider	Using the product and providing feedback	Asking the manufacturer for support	Asking the manufacturer for support	Learning fixed program	
	Open to customers					Deciding if accenting solutions or not
Selection	Directed by the provider	Customers are asked to test				
	Directed by customers		Customers can ask for support at anytime		Customers can receive education if they require	Customers can receive solutions if they require
Benefits	Productivity and efficiency		Utilizing resources of customers	Utilizing resources of customers		
	Product quality	Getting feedback from customers			Getting feedback from customers	Getting feedback from customers

In the design and production phase, customer feedback is collected in several ways, such as by visiting customers. This involvement results in ensuring that the printers fit consumer needs, as well as getting new ideas for future products. However, the contributions of customers in this stage are always led by the manufacturer. It is therefore difficult for the manufacturer to obtain timely feedback from the customers in order to speed the development process. However, other risks were not found in this case study.

6. Discussion

In this study, the proposed framework was applied to the case of a printer manufacturer. As contribution to extant literatures, the result of the case study suggests potential factors that could increase benefits as well as reduce risks. For example, the case study revealed that type of the product and service reduced risks of customer capability in use and maintenance. In this case, the use and maintenance were conducted by customers. This type of involvement eliminated the need for the manufacturer preparing requisite relevant resources, and then increased the benefit of productivity. On the basis of extant literatures, at the same time, this type of involvement is likely to increase potential risks of customer capability, since customers are imposed a lot of tasks. However, the risk of the consumer capability was not found in this case study. The reasons for eliminating this risk can be assumed from viewpoints of type of the product and service. With regard to the service viewpoint, the learning phase in customer relationship lifecycle was support by the manufacturer. The manufacturer collected data in order to pinpoint customers who conducted use and maintenance inefficiently and inappropriately, and then, marketing employees visited them to improve their capabilities for use and maintenance through the education program. With regard to the product viewpoint, in this case study, the design and production phase were conducted by the manufacturer. Furthermore, customers were involved in the test phase, while their contributions were controlled by the manufacturer. This type of involvement enabled the manufacturer to filter customer feedback for producing produce standard printers that are not customized to suit specific customer segments. This standard products could simplify and reduce requisite capabilities for customers' use and maintenance.

7. Conclusion

This paper proposed a framework for analyzing the benefits and risks of customer involvement in PSS development. The proposed framework was applied in case study to reveal the relationship between the type of customer involvement and its benefits/risks in the context of the differing characteristics of PSSs. The results of case study revealed that the framework can be useful support to identify, understand and explain the nature and role of customer involvement in PSS development.

The framework will serve as basis to start developing strategy for customer involvement in PSS development. Future works include conducting further case studies on different kind

of PSS in different industries. Framework generalizability should be proved and testes, but potentialities are high.

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