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Co-creation in the early stage of product-service system development

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Abstract

Co-creation is a well-established topic in manufacturing research. Since 1999 there has been a wide range of publications about the involvement of customers in the design of end products. What is new, however, is the stakeholder, particularly user, integration at the early stage of development of product-service systems (PSS) for concept co-creation. In this paper, we evaluate the methods for PSS development at the fuzzy front-end, before we derive a co-creation oriented method that relies on prototyping at selected stages of the process. The first stage deals with the generation of a shared understanding of the concept to be developed, and in the second stage we converge towards the generation of the user requirements by employing a set of electronic tools to drive process and logic flow thinking within the group of co-creators. The methodology has been evaluated within three workshops involving 42 participants who were asked to design a decentralized bike-sharing system, where bike owners can generate revenues from their bikes by renting them out when not otherwise needed. In a future phase, the results will be compared to the outcomes of a workshop organized with a bike sharing company that is currently developing this model.

Keywords: Co-creation, product-service system, prototyping

1. Introduction

Nowadays, with the change of the market environment and the introduction of new technological trends, such as internet of things (IoT) and cyber-physical systems, that hold the promise to generate further value and change the industrial landscape, a single product is no more considered enough to provide the desired value to the customer [1,2]. The integration of products and services has become a great concern in manufacturing industries [3,4]. The movement is not restricted to manufacturers. Service firms are also upgrading their portfolio to include appropriate products to increase the value of services, fostering the productization of businesses [2]. This integration of products and services marks the transition to product-service systems that dictate the fulfillment of customer needs through these new bundles [5]. Besides, creating true customer value has gained importance since the internet has shifted more bargaining power to customers [6]. Firms integrate customers in the design process to prevent failure and increase satisfaction with improved quality and better targeted offerings [7].

This trend is furthermore relevant when firms seek the integration of new technologies that the customer hasn't experienced yet. The products with cyber-physical features, such as vehicles and machines offer a large spectrum of opportunities to provide new services around such products. However, the state of the art indicates missing engineering tools to support an effective engineering of services around such products [8]. As we adopt a user-centric design perspective, we take a common stance one early concept generation for service design and product design that focuses on maximizing the value for users. However, by combining product and service, new dependencies are generated. A given service could not occur if not a required hardware, and the

hardware itself can open up the door to new use cases, enabled by new technologies, such as the internet of things that allows now the hardware to "speak" and become subject to new design rules, written in the cloud. Such a technology changes the nature of the hardware and confers to it a totally new service behavior.

Thus, this work aims at developing a PSS design method to allow the integration of customers in the early design stage for concept generation. For this, we start by presenting the theoretical foundation, defining PSS, explaining the concept of co-creation and how it relates to PSS design and finally clarifying the concept of prototyping and its importance within the co-creation approach. In the next section, we evaluate the methods for PSS development at the fuzzy front-end, to finally derive a co-creation oriented method that relies on prototyping at selected stages of the process.

2. Theoretical background

2.1. Product-service system (PSS)

PSS can be defined as "an integrated bundle of products and services which main aim is to create utility to customers and generate value" [9]. This notion of utility and value is also found in the early research on PSS, where [4] defines PSS as a combination of products and services in a system that provides functionality for consumers and reduces environmental impact. Also, PSS embodies the transition from "well-being based on the product" to "well-being based on the access to the product" [10]. To this end, services are instrumental for the provision of new access modes and increased value. Baines et al. [11] see 'servitization' as the evolution of the material product where the material component is then inseparable from the service system. Beyond the issue of the product and the service, PSS also strategically integrates communication within the system based on new forms of organization, role reconfiguration, customers and other stakeholders [12].

2.2. Co-creation for PSS innovation

The concept of value co-creation has been discussed for over decades, but empirical examples of how firms actually interact and exchange resources to co-create value with customers are just emerging [13]. Consequently, little is known about the mechanisms and processes of engaging in co-creation, and there are few managerial guidelines on how this process could ideally be structured [14].

Research on customer co-creation has flourished in recent years mainly in two streams of literature: service marketing and innovation [15]. In service marketing, co-creation is a central construct of the service dominant logic (SDL) where customers are active participants in the process of value co-creation (e.g. [16,17]). In fact, SDL views "value as co-created by the service offer(er) and the service beneficiary (e.g. customer) through resource integration and indicates the need for mechanisms to support the underlying roles and processes" [18]. By this means, value cannot be created by the

service offerer, and the latter can only offer a value proposition. Furthermore, the innovation literature focuses on involving customers in the innovation process to design new products for better market acceptance (e.g. [19-21]).

Cui and Wu [15] focused on the innovation stream and proposed three forms of customer integration for co-creation:

- customer involvement as an information source (CIS), where the designers gather input from them and apply it to develop products that meet customers' needs
- customer involvement as co-developers (CIC), where customers develop products together with the designers
- customer involvement as innovators (CIN) where customer are allowed to design their own products, which are then adopted and offered by the firm [22,23].

Co-creation has already been a well-established topic in manufacturing research. Tseng and Du [24], for example, proposed a co-design approach for companies to communicate with customers about current offerings and help customers express their needs and make decisions. When extending the research to consider the manufacturing of bundles of products and services, it is criticized that the PSS design methodology neglects the specification of the roles and responsibilities of the stakeholders co-designing PSS offerings, and that there is a low understanding of the uniqueness of this process and how to implement it in real time [25]. Besides, one of the main differences of PSS from traditional product is the increasing involvement of customers not only in use stage but also in the very early design stage [11,26]. PSS design itself is a participatory design process and users need to be allowed to participate actively in as many design activities as possible [27]. However, even though several examples of PSS co-creation exist in literature, they mainly focus on the production phase while neglect the design phase [28].

2.3. PSS methods with customer focus

In this section, we review PSS design methods that integrate the customer in the design process, to highlight the several approaches and assess the degree of coverage of the PSS design literature for the co-creation phenomenon. Starting from the review of Qu et al. [29], that analyzed the state-of-the-art of PSS methodologies in design, evaluation and operation, we examined the nine methods that they have identified to deal with PSS design with a customer focus. We then searched on Scopus for further articles then narrowed down our selection to 13 articles, presented in Table 1. The analysis and classification of these articles are based on the work of Kaulio [30] who proposes a framework for analyzing the methods for customer involvement in product development. The framework has been then used by Kimita et al. [31] with regards to PSS methods, and reformulated by Cui and Wu [15] as explained in section 2.2. The framework analyses development methods based on two dimensions: the scope or phase of development where the customers are involved, and the intensity that describes how deeply the customers are involved in the process, whether the