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## Value Co-creation in the Context of Digitally-enabled Product-Service Systems

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**Abstract.** This paper describes the development of a conceptual framework to support the identification of value co-creation within the context of digitally-enabled Product-Service Systems (PSS). The framework was developed based on five themes. It considers how and where value co-creation occurs and also the translation of data into information that can become knowledge for individuals and organizations within the digitally-enabled PSS context. The model brings together the different actors and beneficiaries with a governance process that focuses on supporting value co-creation by integrating the information with data. The framework supports new innovation and improvements to existing PSS.

**Keywords:** value co-creation; product-service system; digitalization; servitization; lifecycle; service-dominate logic.

### 1 Introduction

As servitizing activities proliferate within industries, the research focusing on Product-Service System (PSS) advances in line with the research on service-dominant (S-D) logic [1,2]. Manufacturing firms with servitization strategies are moving to PSS-based business models to gain more stable income [3]. Prior studies demonstrate that successful PSS strategies can fulfill diverse customer needs and enhance resource efficiency by extending product lifecycles[4].

Despite these potential benefits, adopting PSS proves complex for firms for designing and implementing successful service strategies [5]. This is because PSS provides a complex environment consisting of multiple actors, stakeholders, and beneficiaries in the context of servitization [6] and the machines within the system. A paradox is developing that hinders exploitation of digitally-enabled solutions in PSS [7]; it is due to the transformational aspects of digitally-enabled PSS and servitization[8]. A lifecycle perspective is useful when considering data and information flows and how they can assist value creation [9]. Value co-creation has been identified as a complex process in this context and requires further investigation.

This study aims to explore this in digitally-enabled Product-Service Systems (PSS) along the lifecycle. It provides initial input into a framework that supports value co-creation in digitally-enabled PSS, which will then be developed further. .

## 2 Research Framework and Methodology

PSS and servitization are mature fields that are closely tied to lifecycle management and value co-creation. The application of S-D logic is a core tenet of servitization, notably within the definition of advanced services [1,2,3]. The concept of value (identification, creation and capture) in digitally-enabled PSS in industry however, remains poorly researched over the lifecycle. The literature remains generally fragmented, with limited integration from different research fields. For this reason, an integrative literature review has been chosen as the most appropriate approach, bounded by the concept of PSS in an industrial context, the product lifecycle, and value co-creation, allowing the integration of knowledge from other disciplines [10]. The review outcome will be a theoretical framework that can be applied, tested, and improved in the future.. The literature has primarily been selected from the Web of Science. Selection of relevant and insightful literature was initially based on keywords, title and abstract: “*value co-creation*” OR “*value creation*” OR “*value propositions*” AND “*manufact\**”.

## 3 Integrative Literature Review

Based on the thematic content analysis investigating the aspects of value co-creation, papers were analyzed into five categories: value creation processes, lifecycle governance of value co-creation, PSS based value propositions, value creation and advanced services, and value creation in the digitally-enabled PSS. The literature is summarized in Table 1 segmented based on these five categories. The number of papers identified is given, along with the key references used to build up the sub-sections in this literature review. They support building an initial framework that supports value co-creation over the lifecycle of PSS. 157 papers were found initially, before the final selection in Table 1, where the papers used in each critical review are listed,

**Table 1.** Overview of the literature

Theme	Papers	Cross-related to themes
Value creation processes	11	7
Lifecycle governance of value co-creation	8	0
PSS based value propositions	6	1
Value creation and advanced services	15	13
Value creation in digitally-enabled PPS	15	9

### 3.1 Value Creation Processes

To create value, two actors must be involved in a service ecosystem [11]. The value co-creation process is based on the integration of their explicit and tacit knowledge to develop a solution [12], the ecosystem is important because many actors and machines can be involved in the value creation process [13]. Shedroff [14] applies aspects of interaction design to understand value co-creation in terms of control/feedback, productivity and adaptability, this is in line with SD logic [15]. Value co-creation is not a single event, Grönroos [16] expanded on this along the product lifecycle with a focus on the beginning of life and the middle of life [17]. Bertoni et al., [18] visualized the links between value in use and value in exchange. Journey mapping can also be used to investigate the value co-creation processes [19, 20]. Describing value (i.e., financial, tangible, intangible, etc.) to parties who are involved demonstrates the outcomes to the stakeholders and the beneficiaries [21].

### 3.2 Lifecycle Governance of Value Co-creation

Value co-creation in an advanced service agreement occurs over the product's whole lifecycle providing opportunities to create value, which is described as 'sharing pains and gains' in some contexts [1,22]. Advanced service providers are dependent on the ecosystem's resources to achieve the desired performance [23,24]. Changes to laws and partner behaviors, technologies, or markets may shift the equilibrium of value co-creation and require a realignment to achieve a new win-win position [25]. Institutional arrangements are necessary to support the re-alignment and hence governance of the value co-creation and resource integration [26]. Generally, the more successful forms of contact were longer-term oriented and reflected collaborative working [27]. However, role ambiguities were identified as key challenges in the servitization process.

### 3.3 PSS based Value Propositions

Servitization strategies may be delivered by a firm through PSS, as it enables them to create more value for customers and has aspects of SD logic embedded within [3]. The approach (together with digital servitization) provides customer integration and models that focus on value co-creation and capture [7]. The classification of the value propositions within a PSS context has been developed to support the understanding of the services (revenue model and nature of the value proposition) [28]. For digitally-enabled PSS a model has been proposed that provides additional insights into the value propositions [7]. This work agrees with others that describe new digitally-enabled value co-creation in PSS contexts [29,30], where value capture can be problematic as firms fail to change business models [31].

### 3.4 Value Creation and Advanced Services

Advanced services focus on the outcomes delivered through the product's performance [31,33]. These outcomes are based on explicit and tacit knowledge being exchanged among different actors. Digitalization can support the exchange of information to increase perceived 'customer value' [31]. The delivery of advanced services requires many actors to deliver the expected performance, and value is often co-delivered for the beneficiary [34]. The development of digitally-enabled PSS takes place with the customer through a process of value co-creation [16]. As a company moves towards advanced services, the product becomes a distribution mechanism for the services as the firm shifts into SD logic from goods-based logic [2,15]. Advanced services require a firm to reframe its position within the value creation process over the whole lifecycle, reinforcing the SD logic [12, 2]. The integrator's role to moderate interactions for value co-creation in industrial settings has been investigated [35,36]. Within SD logic, value co-creation is supported by integrators (or moderators) applying resources along the lifecycle to help customers in their own value-creation processes [2,12,15]. Information and interaction design can be supported with digital tools, supporting the integrator to transform data into knowledge [14]. The interrelationship between data, information, knowledge, and wisdom, are explored in the literature [37,38,39].

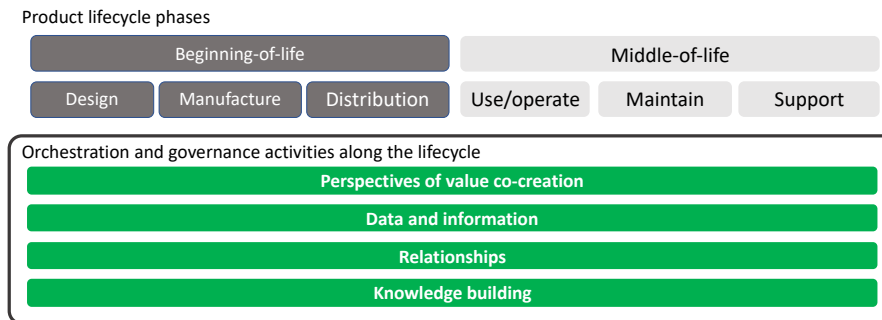
### 3.5 Value Co-creation in the Digitally-enabled PSS

Data alone cannot create value [40]. The difference between data and information is not structural but functional [38]; visualization makes it meaningful [18]. Data can be considered information only if organized, presented as relevant, usable, significant, or meaningful answers [41]; only then can knowledge be built up through multiple interactions [42]. Knowledge originates from information integration and exchange, which in turn generates experience [39]. According to the literature [2,15], value in PSS delivery is continuously created through interactions between multiple actors, who act as the resource integrators, forming ecosystems of service offerings and exchanges [43]. It is co-generated through the reciprocal application of resources by the integrators to benefit a receiving entity [2]. The system integrator orchestrates the ecosystem in such a configuration allowing actors to contribute actively [44]. Value co-creation can be achieved by establishing different types of participant engagement; value capture needs the active involvement of at least two actors in the service ecosystem [45].

## 4 Framework for Value Co-creation in Digitally-enabled PSS

In this study, the framework developed (Figure 1), based on the literature, supports value co-creation in digitally-enabled PSS in an industrial context. In many cases, the operational life of the equipment is tens of years., This is a limitation on the framework, although, it provides a clear set of boundaries be later validate. The framework builds upon the five thematic blocks, providing an initial framework to support value co-creation. The framework is based on dyadic relationships as this is simpler than triadic

(or more) . The framework supports and promotes the exchange of explicit and implicit knowledge to be integrated into a solution delivering the value co-creation process for the beneficiaries [12]. The framework applies feedback between the parties, supporting productivity, and adaptability from integration design, to aid build knowledge (within and between different life cycle phases).



**Figure 1.** Framework to supporting value co-creation along the product lifecycle

The integration of the actors at each phase of the lifecycle and between each phase, needs orchestration to ensure two-way flows [9]. Each touchpoint or transaction between actors provides an opportunity for value co-creation. Starting from the beginning of life, value co-creation is possible, although in PSS there is a tendency for a good-dominant logic approach to apply. During the middle of life, there are many situations where value co-creation and co-delivery can occur, and the impulse may be from people, operational, or technology changes. Here it is necessary to adapt to maximize the value co-creation and value capture opportunities and share the lessons with the installed base and to the team focused on the beginning of life phase. To achieve value co-creation across the lifecycle, four aspects identified from the literature form the basis of the framework: i. perspectives of value co-creation; ii. data and information; iii. relationships between actors; and iv. knowledge building. The connections between the beginning of life and middle of life must be actively supported and encouraged (orchestrated via the support of a resource integrator).

Building long-term relationships, based on institutional structures (e.g., contracts), between the actors in the ecosystem is essential to support the orchestration and governance of value co-creation (via a moderator/resource interrogator) [19,20]. Value is generally co-created through in-depth interactions and intensive capability integration between the actors. These interactions are based on exchanging data, information, and knowledge between many actors who are in effect participating in value co-creation over the lifecycle for a range of beneficiaries. Moderators/resource interrogators support the relationship between different actors in the ecosystem and are in effect “valuable bridges, as they give one actor access to the resources of another” [46, p68].

## 5 Conclusions and Recommendations

The integrative literature review unifies different research themes from different academic perspectives and creates a framework to support value co-creation over the PSS lifecycle. This is particularly important where there is a digital aspect to the system. The framework created needs to be tested and refined, while further research is needed in the multidisciplinary area.

The framework supports value co-creation along the PSS lifecycle. It confirms that firms need to determine new approaches for collaboration to improve value co-creation and co-delivery processes and allow them to adapt over the full life cycle of the PSS. Digitalization increases the availability of data and derived information, and though orchestrated collaboration this can be used to support value co-creation through a closer collaborative approach. Therefore, companies moving towards digital transformation would enhance value co-creation during their products' lifecycle.

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