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The Impact of Co-Creation on the Design of Circular Product-Service Systems: Learnings from a Case Study with Washing Machines

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Designers play an important role in service transformation and the development of product-service systems by applying co-creation methods. This paper

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presents a case of how we applied co-creation in practice and the impact this has had on developing a circular product-service system. It details the method used in the co-creation process and highlights five benefits, such as the ability to develop value-adding services for repairs and supporting each of them with user citations. Furthermore, we interviewed the project team a year into product development to assess the uptake by the company and the impact co-creation had on their design process. Based on these findings, we present a conceptual model that identifies the tangible impacts of co-creation and visualizes at what stages and levels co-creation can impact both the development of product-service systems and a company's shift along the servitization continuum.

KEYWORDS: co-creation, product-service systems, circular product design, washing machines, access models, impact

Introduction

Co-creation methods enable users and other relevant stakeholders to participate in the design process of new service and product offerings (Holmlid et al. 2015; Sanders and Stappers 2008). Co-creation has become well established in recent years (Sánchez de la Guía, Cazorla, and de-Miguel-Molina 2017), but to date, this approach has received limited attention from the circular economy community and in the development of circular product-service systems (PSSs) (Lofthouse and Prendeville 2018; Selvefors et al. 2019). Yet Cherry and Pidgeon (2018) argue there is an urgent need for research on 'how these new business models may be perceived.' In circular PSSs, also referred to as access models, product-as-a-service models, or pay-per-use models, the legal ownership of a product remains in the hands of the manufacturer or service provider who sells the product's right of use for a limited period of time.

These new business models are seen as a key factor in successfully closing loops in a circular economy (Ellen MacArthur Foundation 2013). It is therefore important that people actually start using circular PSSs on a sufficiently large scale. For that, as Selvefors et al. (2019) state, 'It is essential to increase the understanding of what circular consumption entails for people in everyday life.' To ensure that the circular product-service-systems are optimally aligned with user (future unmet) needs (Sleeswijk Visser et al. 2005), we need to account for people's aspirations, ideas, fears, and dreams. This is the starting point for co-creation as a design approach to PSS development/innovation.

This paper describes a case study into the role of co-creation and its impact on the development of a circular PSS for washing machines in a multinational whitegoods company. The case study

takes a designerly perspective to answer the research question: how can co-creation contribute to the development of circular PSSs and how can the uptake of the co-creation results be stimulated?

The development of (circular) PSSs is part of a bigger move towards servitization, which is defined as 'the innovation of a manufacturer's capabilities and processes to move from selling products, to selling integrated product-service offerings that deliver value in use' (Baines, Lightfoot, Peppard, et al. 2009). In general, servitization is a longstanding research field where collaboration or 'co-development' is confirmed to have 'a marked effect on the achievement of service innovations in manufacturing firms' (Roos 2015). However, we can also find gaps in this field, particularly in how designers can contribute to service transformation (Overkamp 2019). Servitization requires significant changes to the logic, processes, and capabilities of companies (Roos 2015; Baines, Lightfoot, Benedettini, et al. 2009). Roos addresses the 'need to analyse service, product, and process innovations together in order to understand the innovation processes of servitized manufacturing firms better' (Roos 2015). The literature identifies a number of benefits of co-creation (Steen, Manschot, and Koning 2011) and notes potential key performance indicators to measure the impact of co-creation (Roser et al. 2009) but these remain fairly abstract with few meaningful practical examples. This paper therefore contributes to the servitization literature with its description of an actual case of circular PSS co-creation. It also assesses the outcomes at product and service-design level, and tracks the company's transition along the servitization continuum 'from pure-product to pure-service provider' (Oliva and Kallenberg 2003; Slepniov, Waehrens, and Johansen 2010).

We first introduce the concept of co-creation and related methods as a prelude to a detailed description of the co-creation process used within this study. The data analysis method as well as the results of the co-creation process is detailed using infographics as well as by presenting the direct benefits of co-creation for the company. Furthermore, we give a broader perspective on the impact of co-creation on the design, the design process, and the company itself, and the learnings that can be drawn from this. The paper concludes by combining direct and indirect results and distilling general learnings on success factors, the impact of co-creation on design (processes), and the effect on the company's transition along the servitization continuum.

Background

We refer to co-creation in this paper as a series of creative sessions with users, in which new service ideas are developed from user insights and first ideas are iterated on through user feedback. Co-creation is part of the larger domain of co-design. Literature is available (Mattelmäki and Sleeswijk Visser 2011; Sánchez de la Guía, Cazorla, and de-Miguel-Molina 2017) about where these theories

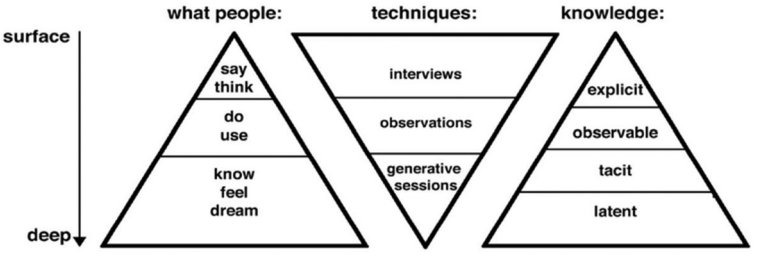

Figure 1.
Different levels of knowledge about experience are accessed by different techniques (Sleeswijk Visser et al. 2005).

originated and how they intertwine and continue to evolve, but central to the co-design approach to design is the concept of multiple parties collaborating in different phases of the design process. However, co-design is much more than collaboration; it is about a mindset that involves users and/or stakeholders and utilizes their competence, experiences, and creativity over time (Mattelmäki and Sleeswijk Visser 2011).

There has been a continuing discourse on how users can participate as co-creators in a design process. A user can be seen as an information provider, a creative mind, an evaluator of new ideas, etc. Some companies are sceptical about user involvement in the creative process, taking the stance that users are not able to think into the future, stick to what they know about the present product or service use, and inhibit creative explorations for future use. Others have different views, e.g. Sanders states that users can be creative as long as they are guided in a process of collective dreaming about the future (Sanders and Stappers 2014). In this study, we regard users as 'experts': while designers are 'experts of the creative process', users are involved as 'experts of their own experiences'. We applied generative approaches to guide users into exploring and expressing their own experiences and needs, in combination with interviews and observations (see Figure 1) (Sleeswijk Visser et al. 2005).

In generative group sessions, the users' experiences become explicit by having participants make things and share their stories with others. By making things, e.g., a collage, a sketch, a timeline, or a 3d form, participants enter a creative space grounded in their own experiences which helps them express these and their needs. Participants are facilitated in this process of examining their experiences in the present and in the past; only then are they guided towards exploring possible needs towards the future. This process of reflecting on present and past experiences starts with a sensitizing phase; often a diary-type booklet or a collection of open materials to document service use in their personal everyday context over a period of one or two weeks prior to the interviews or group sessions.

The creations participants make are regarded as vehicles for expressing experiences. The possible solutions they propose are not

the results to continue with; it is in the stories they tell where needs for the future can be identified and coined as user insights. The user insights then form input for following design phases such as concept development. Often during concept development, new stakeholders join or take over; these also need to have a rich understanding of these insights. Therefore, communication strategies are preferred that not only inform but also inspire idea-generation and promote empathy with users to achieve a rich understanding of their experiences (Sleeswijk Visser 2009). Communication tools that can convey this richness are, e.g. person profiles, personas, customer journeys, and videos (Segelström 2012). These user insights need to be actionable for the innovation teams, steering idea-generation while grounding the insights into the everyday user-experiences. A combination of different abstraction levels of the data promotes this actionability, for instance a combination of clustered thematic insights and raw data elements such as videos or quotes.

Method/approach

In this section, we explain the method, setup, and analysis of the co-creation process itself followed by how the insights were implemented by the company. In addition, we describe how the authors gathered information on the long-term uptake of the co-creation results by the company.

Co-creation: setup and data analysis

The case study involves a multinational whitegoods manufacturer based in Eastern Europe. They plan to pilot circular PSSs for washing machines in four European countries as part of the EU ReCiPSS[1] project. The co-creation study was conducted in two countries, the Netherlands and Slovenia, as being representative of the North and South-European context. This gave the ability to verify if the same needs, concerns, and opportunities were valid in different cultural contexts. During two user sessions, representatives from the project team and the company were present as 'fly on the wall'. After the two user sessions, the company team ran follow-up sessions with the project team, company project team, and different departments for concept development and new business models.

Session formats and participants

In total, 17 washing machine users (NL, 7; Slo 10) participated in the first two sessions. Table 1 gives an overview of the participants, all of whom were the main washing machine user in their respective households. Three were active users of a washing machine with either pay-per-use or a monthly subscription model. The others were selected based on their varying experiences with other products offered through access models such as bicycle or car sharing

Table 1. Overview of participants.

nr	*country*	*Age*	*Gender*	*Married/ cohabitating*	*children*	*Experience with access models*
1	NL	48	M	No	No	–
2	NL	62	F	No (LAT)	Yes	–
3	NL	35	M	Yes	Yes	Pay-per-use washing machine
4	NL	47	F	Yes	Yes	Laundromats (camp sites and petrol stations)
5	NL	45	F	Yes	Yes	–
6	NL	21	F	No	No	Pay-per-use washing machine
7	NL	32	M	Yes	No	Pay-per-use washing machine
8	Slo	25	M	Yes	No	Shared washing machine (dormitory)
9	Slo	29	F	Yes	No	Bike sharing
10	Slo	29	F	No	No	Shared washing machine (dormitory)
11	Slo	31	F	Yes	No	–
12	Slo	33	M	Yes	Yes	Bike sharing
13	Slo	36	F	No	No	Laundromat, bike sharing
14	Slo	38	M	No	No	–
15	Slo	50	M	Yes	Yes	Bike sharing
16	Slo	54	F	Yes	Yes	Laundromat
17	Slo	55	F	No	Yes	–

services. To obtain rich insights, participants with a diversity in age, gender, and family situation were selected; however, we did not test whether the sample was representative of the whole population.

The first session was hosted in the Netherlands; the second in Slovenia. The study consisted of filling in a sensitizer booklet about the current washing machine practices (Figure 2) before the workshop, and then participating in a co-creation workshop. The sensitizer booklet was used as a basis for the workshop group discussions (Sleeswijk Visser et al. 2005).

The sessions were split into two parts. The first half was an in-depth group discussion, which delved into the user's laundry experiences. In the Dutch session, mixing users who used a pay-per-use washing machine with 'normal washing machine' users provoked a natural dialogue in which users exchanged their laundry experiences. In the second half, participants were asked to create a scenario for their ideal laundry service in pairs. To facilitate this, they were provided with a toolkit to co-construct a storyboard that expressed their

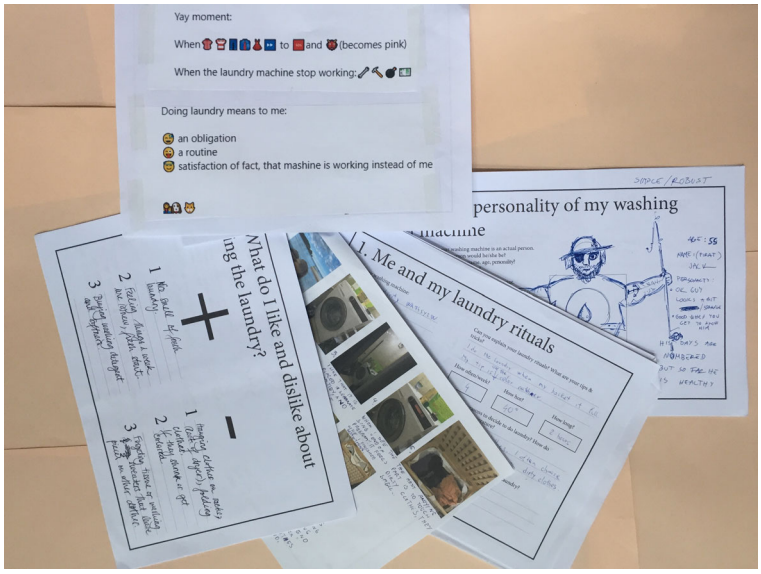

Figure 2.
Extracts from the sensitizer booklets filled in by the participants.

ideal scenarios. The toolkit was based on the scenes tool (SAP n.d.) and included prints of human characters, room settings, objects related to laundry, etc. In the second half of the Slovenian session, the scenarios from the Dutch session were presented. The Slovenian participants had less experience with access models and this setup evoked participants reactions and helped them iterate on ideas from the first session.

Data analysis

We performed a thematic analysis to identify the main categories and to gain relevant insights (Corbin and Strauss 1990). As a first step, facilitators from the ReCiPSS project familiarized themselves with the data by repeatedly listening to the recordings. In an iterative process using an inductive approach, key topics were distilled from the participants' recordings, sensitizers and designs, and arranged on whiteboards. These included key and noteworthy facts for each participant and their washing rituals, how they viewed their washing machine, and their likes and dislikes. By analysing these topics and facts, four overarching themes were distilled. Key insights and recurring subthemes relevant to the development of new PSSs were identified for each theme. The first author then went through the recordings consecutively to select transcribed quotes to include in the infographics.

Communication of insights: infographics

The exploratory nature of the design challenge in this study mandated that a substantial number of insights needed to be presented

in a manner that was easily accessible to the company project team and that allowed them to empathize with the users (Sleeswijk Visser 2009). Therefore, infographic posters with personal profiles (one for each participant) were made as they present an extensive graphic summary of the relevant data while retaining the personal identity of the users through the inclusion of pictures, drawings, and significant quotes.

Implementation co-creation insights in product development

The implementation of the user insights in the product and service development was instigated through close cooperation between the company and the ReCiPSS project teams. Two workshops were held with the project teams to analyse the results together, and to initiate the design process and generate ideas. Using the infographics, the participants brainstormed new services for the persons portrayed. The process of idea-generation for the circular PSS was then continued by the company project team, consisting of the head of pre-development of R&D, the project manager, lead R&D engineer, a market researcher, and an intern. This led to the generation of an extensive number of ideas through company-internal creative sessions. These ideas were subsequently narrowed down to a selection that was incorporated in the product and service development.

Setup interview

One year after the co-creation phase, three members of the company project team (the head of pre-development of R&D, the project manager, and the lead R&D engineer) were interviewed together by the first author to reflect on the co-creation process. The semi-structured interview took 25 minutes and allowed the participants to reflect on and probe the co-creation process and uptake. They were asked about their expectations beforehand, whether these expectations were met, what kind of impact the co-creation process had, and which factors facilitated/obstructed the use of the co-creation insights. The interview was anonymized, transcribed, and analysed to extract key insights.

Results

This following section highlights the results from the co-creation phase in the design process focusing on three aspects: a.) 'the infographics' – the proximate outcomes of the co-creation data analysis; b.) 'the direct results', which identify the benefits for direct PSS development flowing from this co-creation phase; and c.) the long-term uptake by the company, which was gathered through the interview with the company and make up the 'indirect results'.

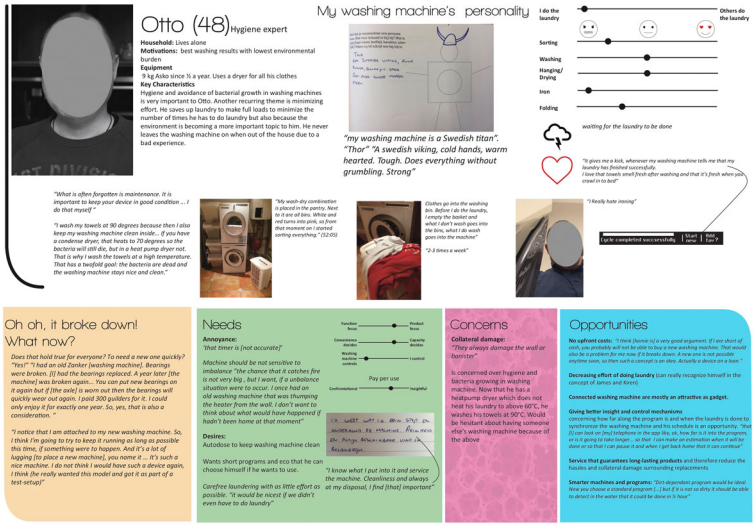

Figure 3.
Infographic example – Otto.

Infographics

A total of 17 infographic posters were created (one for each participant) based on the data analysis (see examples in Figures 3 and 4).

The top half of each infographic focuses on the participant's key characteristics, their laundry practices, likes and dislikes, as well as the way they perceive their washing machine's personality. The bottom half of the infographic portrays the four overarching themes identified, from left to right: issues surrounding breakdown and repairs of washing machines; user's (innate) needs, frustrations, and desires concerning their current laundry practices; their concerns; and the opportunity spaces that emanated from what participants said during the session.

Direct results co-creation – company benefits

Five company benefits of using co-creation were identified in this study; each is supported with participant quotes.

Benefit 1: Helped create added value in offering the washing machine as a service

The use of co-creation revealed several areas that can make a washing machine-as-a-service relevant to users. It does, however, require significant changes in user behaviour, and therefore, these circular business models need to have clear user benefits in comparison with owning a washing machine (Selvefors et al. 2019). One example is in the area of service and repairs, where a rapid response time, including an instant repair or washing machine 'swap' service could be part of the service offering. As one participant stated: 'I would be

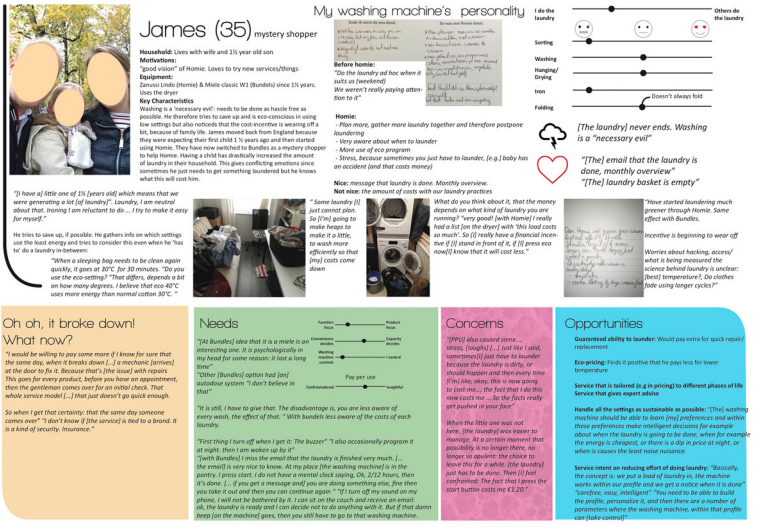

Figure 4.
Infographic example – James.

willing to pay more if I knew for sure that the same day, when it breaks down, a mechanic would arrive at the door to fix it. Because that's the issue with repairs … that whole service model, just doesn't go quickly enough. So, if I get that certainty - that the same day someone will come over … it's a kind of security or insurance.' Another example is the opportunity for service providers to give relevant and timely information and feedback: 'I really miss the email [from the pay-per-wash service provider] that the laundry is finished. [the email] is very nice to know.' This participant highly appreciated the PSS's discreet email message over the forceful beeping noise the washing machine makes on finishing the wash.

Benefit 2: Allowed the development of attractive pricing and contract options

A long-lasting washing machine is a durable good that can (potentially) have a lifespan of 20 or even 30 years. While durability in itself may be attractive to some users, it can also give a certain rigidity that may not be attractive to (younger) users who value flexibility. One pay-per-wash-user (32 years old, living together with his girlfriend) described the appeal of pay-per-wash as follows: 'Not having to pay upfront costs. You don't need to pay for a washing machine. You are not stuck to it. For example, if you move to another country, you aren't left with a washing machine that you need to get rid of.' A washing machine with a long lifespan also cannot accommodate changing lifestyles and, in particular, changing household compositions as families grow or children move out. Access-models may have the advantage that the service can be adapted or tailored, e.g. regarding the size of the machine, payment options, and flexibility of

contracts. Pricing schemes are crucial but need to be considered carefully especially with families, as one participant said: 'When the little one was not here, the laundry was easier to manage. At a certain moment that possibility is no longer there: the choice to leave the laundry for a while. It just has to be done. Then I feel confronted: The fact that I press the start button costs me €1.20.'

Benefit 3: Helped find unique value propositions

Co-creation helped identify opportunities to differentiate the company from their competitors. It is essential that companies find unique value propositions for the proposed circular PSS, particularly if they are not the first on the market to offer access models. Given the sensitive nature of this benefit, the authors cannot go into too much detail, but an example of a potential value proposition is providing washing machines with smart technology that users want, but would otherwise be financially out of their reach, like providing Wi-fi-enabled intelligent maintenance, or remote access to information and control mechanisms concerning when the program will actually finish. As a user noted: 'I would probably get a subscription just because of this.'

Benefit 4: Identified potential user concerns

The co-creation session intentionally combined users with a pay-per-use washing machine and users with a classic ownership-model. This approach brought to light certain reservations that users had including issues surrounding freedom, control, privacy, (dis)trust, and (hygiene) perceptions. Several users were, for instance, very aware of hygiene issues and therefore wary of (re)used and shared washing machines: 'Because my sister studies biology, microbiology and she scared the shit out of me […] there was a study that the bacteria that live in washing machines can actually be harmful to you.' Another example was lack of choice 'I would want to choose, what [the washing machine] looks like, what it can do. I find it important that it can open after the program has started, so that I can add forgotten socks, … I would have real problems with - oh, you get this concept and this is the machine.'

Benefit 5: Helped pinpoint cultural differences

The sessions were held in Slovenia and the Netherlands. The approach of using the first session as input and verification during a second session in a different culture made cultural differences identifiable. One example of this is that Slovenian participants seemed more prone to question the concept of warranty and were wary of 'empty promises', as one participant stated: 'I would probably go for

the cheapest one just because I don't know how they can guarantee that the other one is really going to last so much longer.'

Indirect results – uptake by company

To analyse the uptake after a year, the lead engineer, project manager (PM), and department head (DH) were interviewed together. The interview resulted in a number of valuable insights. In this section, we focus on three aspects: the impact on the company itself, the impact on the design of the PSS, and the factors that made co-creation successful in creating impact in these areas.

Impact on company

Company impact 1: company-wide support for the pay-per-wash concept. Co-creation gave the project team broader support within the company for the development of the new PSS. Firstly, it gave them negotiation power: DH: 'That we gain the negotiation power for our new features because when we discuss these with brand or category managers, we have very strong arguments that say: ok, but this is the result of the co-creation workshop. This is actually what the market demands.' PM and DH: 'It [Market demand] is a key word.' DH: 'Because the management [. . . .] has difficulties understanding why someone would like to rent an appliance if they have so much money that they can easily buy the most expensive one.' If the management are not provided with user insights, they may not recognize user needs because they rely too heavily on their own needs concerning washing machines.

Company impact 2: development of employee's competencies. For a company to successfully move along the servitization continuum, employees need to develop new skills and competencies, and co-creation assisted in this process. Management changed their perspectives through the insights gathered, and the project team members also felt they had changed, particularly in applying an empathic approach to design. DH: 'the process changed us as well, for sure. [. . .] as technicians we didn't expect much from the co-creation workshop because we are the experts about the washing machine, but in the end, we [were] very positive and surprised by the outcome [. . .] it exceeded my expectations dramatically.' The engineer: 'You know, we are experts but none of us is actually [the person who] uses the washing machine at home.'

Company impact 3: broader use of co-creation within company. The project team indicated that co-creation is a tool regularly used within the product development process in the company, but that very few departments are involved. DH: 'So [Usability testing and Co-creation] is part of the formal development process. Probably we

have the problem that in this co-creation the engineers are not involved, so it is only non-technical people.' In our case study, marketing and engineering were involved in idea-generation, but the design department far less. The engineer: 'We will now include the product design department and we will start talking about it, now it is in the roadmap. When we start defining the details, we will include them.'

Impact on design PSS

PSS Impact 1: shift from dedicated washing machine to software innovations. The development of the PSS is still ongoing. A year after the co-creation sessions, several findings had been implemented in the development process. As a direct result of user insights, the team decided to shift from their initial idea of developing a dedicated 'PSS washing machine' to developing software innovations that would enable all machines to be 'PSS ready'. By investigating the options WIFI connectivity would afford, software solutions were developed that enable both pay-per-use and classic ownership as well as other functionalities necessary or beneficial for the PSS. The co-creation session had been the trigger in this case rather than technical feasibility or financial considerations. The engineer: 'You know, when you get some new information about how a product should look, it is not necessary to build it from scratch. It does not make a lot of sense to build it from scratch because you need to adapt what you have'.

PSS Impact 2: new servitization innovations. The co-creation insights impacted the servitization ideas that were developed and implemented both for the new circular PSS as well as for the broader product range, e.g. with regard to repair services: DH 'how they [the participants] were thinking about getting the response from the repair. All these were included.' Particularly interesting was the spill-over effect to the development of their existing product range and accompanying services e.g. with regard to providing, feedback, information, and push notifications. The engineer: 'The co-creation sessions were not only about pay per use systems. They were about washing machines in general. A lot of things are now included in the [mobile phone] app that we are designing [for all washing machines]. We are also designing the web interface. So, a lot of these things are included in these designs.' DH 'if you ask me what in this process had the most influence on the outcome, it was the co-creation.'

Success factors

Three success factors were identified through the interview.

Success factor 1: product champion who took the lead and drove the process of turning insights into ideas. This factor is generally termed a 'product champion' in the literature. Shane (1994) defines a product champion as people who are 'motivated to absorb the risk of overcoming organizational obstacles to innovation because they have different preferences from the majority of organization members' and identifies six valuable roles they play in innovation processes.

Several of Shane's (1994) product champion roles can be recognized in 'the intern' (Pam). Key roles she fulfilled were gathering organizational support by building coalitions, facilitating consensus building between managers, driving and energizing the creative process, and as external party, being able to sidestep the organization's usual rules and procedures. Examples of building coalitions and consensus outside the usual rules were, for example, blocking management agendas to work with the infographics. DH: 'She was [the] facilitator in principle' … 'She was a very tough negotiator with us.' … 'I must say, that it was really critical that we had Pam on board […] because, in principle, we were all biased […]; she was completely independent, she had no filter.' Examples of driving the creative process can be found in her extensive idea-generation strategy: PM: 'She analysed all these sentences of the co-creation posters […] sentence by sentence.' The engineer: '[then] you start to think about this a little bit differently, and you can create two or three more user stories from this user story.' Otherwise, we would just: 'Ehhh, that's not important' at the beginning. So, it would be much less insight.' A further example is the energizing effect of the product champion the team identified: Engineer: 'Personalities I think, [Pam] fitted really well into our team. DH: 'She wanted to create the change.'

Success factor 2: Positive energy emanating from creative process. In addition to the energizing effect of the product champion, the actual process of working with the infographics was perceived as fun by the project team members and it gave them positive energy. The engineer: 'You can see that we, all the time were having fun also without [Pam].' to the extent that other colleagues were asked to join in.'

Success factor 3: Infographic posters as valuable carrier/medium to convey insights. In addition to the previous success factors, the project team also identified the carrier/medium as a success factor in their ability to implement the co-creation data. Literature (Sleeswijk Visser 2009; Segelström 2012) shows that making the data accessible is crucial to create empathy for the user, and the project team confirmed this. Engineer: 'They were the base for all ideas that we got from this co-creation. Because we read these posters many times, you had insights about the person: You could imagine: this is a mom; she is doing this and this and this. You had this personal connection with … , like you know her.' DH: 'Because also, as the researchers, you could then actually put yourself in someone else's shoes easier.'

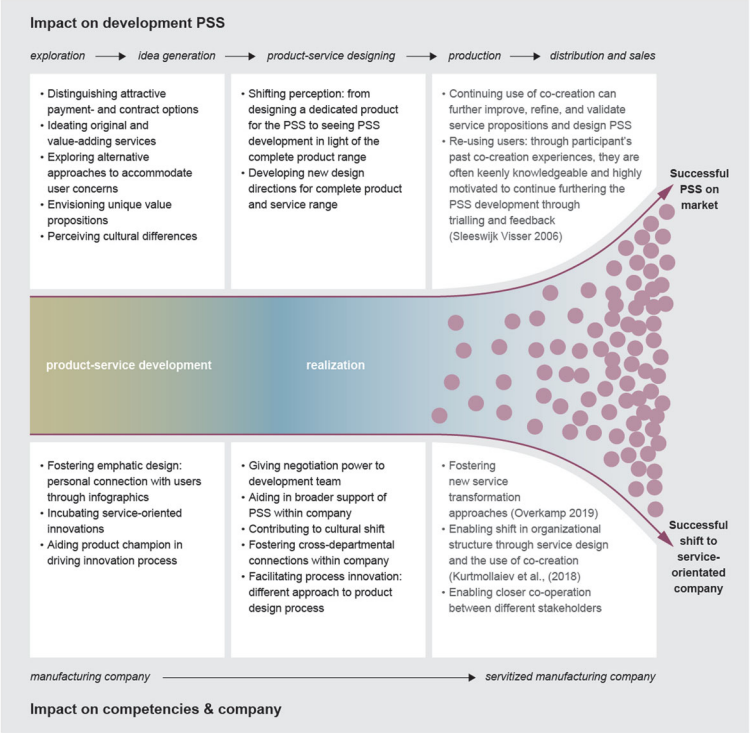

Figure 5.
Conceptual Model of the impact of co-creation.

Reflection and discussion

In this section, we frame the findings in the context of the product development process (Van Boeijen et al. 2014) and reflect on them in the light of previous literature and the limitations of co-creation.

Learnings from case study

An important learning from this study is that co-creation can have impact at different levels, stages, and processes. In this case, two processes occurred simultaneously: the company was developing a new PSS but was also shifting along the servitization continuum (Oliva and Kallenberg 2003; Slepniov, Waehrens, and Johansen 2010). Co-creation impacted both significantly as visualized in the conceptual model (Figure 5).

The horizontal funnel denotes the product development process and shift along the servitization continuum over time, with the wide end of the funnel portraying a successful market penetration. Along the stages of this timeline, co-creation has different impacts, which are separately identified for both the design of the PSS and the company, based on results from this case study.

This way of visualizing and framing the role of co-creation is uncommon in literature and highlights the role for designers and their application of co-creation in service transformation; this has only

recently started to be explored (Overkamp 2019). The conceptual model supports the 'benefits of co-design in service design projects' identified by Steen et al. (Steen, Manschot, and Koning 2011), with the added value that more evidence is given through concrete examples and that it highlights the importance of the product champion.

Where a company starts and finishes along the servitization continuum is not visualized in the figure. A company may be completely new to servitization or already be partly servitized so these processes may not be within the same time interval. The model's benefit is in visualizing where co-creation can be of impact along this spectrum. Companies can apply this approach, e.g. when shifting their product development processes towards service-orientation (Martin and Horne 1992).

Relevance to development of circular PSS

The case highlights how co-creation can benefit gaining traction and support within the company for new ideas, bring different departments on board, and aid in the development of the new competencies and capabilities essential to servitization maturity (Holmlid et al. 2015). Particularly, co-creation can be a pivotal, positive disruptor in transitioning from product development to PSS-development (Wetter-Edman, Vink, and Blomkvist 2018). Shifting towards circular economy strategies requires significant changes and novel ways of thinking within an organization and alternative strategies, such as co-creation, can be vital to create breakthrough in shaping new PSSs. Co-creation is particularly fruitful when different departments with different expertise join in and develop ideas together, but this requires dedicated effort and can be counterintuitive to company culture, as this case showed.

Within the Circular Economy, the importance of involving users in the development of circular PSS has been increasingly emphasised in the literature (Selvefors et al. 2019). The results of the case study confirm the benefits of co-creating product-service offers together with end-users. Specifically, the conceptual model identifies how co-creation can tangibly benefit the development of PSSs and servitization, both of which are crucial to access models, and key circular economy concepts (Ellen MacArthur Foundation 2013). This approach thus merits more attention within the development of circular PSSs.

Relevance to co-creation methodology

Our study highlights the importance of not leaving uptake by the organization to chance. Previous literature has identified the importance of mediums, such as personas, videos, and infographics, to transmit insights to the design team (Sleeswijk Visser 2009; Sanders and Stappers 2012; Segelström 2012) but more is needed to spearhead this process to ensure that companies incorporate and absorb results. Steen et al.'s (Steen, Manschot, and Koning 2011) second case revealed that the departure of the product champion resulted in

the discontinuation of the ideas within the company, yet they did not identify the importance of a product champion as such. Our research shows that the uptake should be a focal point from the onset of the co-creation process. As part of this approach, it should be ensured that the co-creation fits well within ongoing developments and processes, and that there is a person to lead the further implementation process.

A further area of relevance is the measurement of impact. Due to the iterative nature of design processes, it can be difficult to pinpoint the origin of an idea and thus give concrete evidence of the impact of co-creation. Nonetheless, this deserves more attention within the field of co-creation. Furthermore, our case demonstrates that co-creation can be relevant for identifying cultural difference and dimensions. Yet, this area, including how to execute these studies and the impact of language barriers on the co-creation process, has been neglected in the co-creation literature. Expressing underlying dreams and feeling and latent knowledge in another language or through a translator can hamper creative facilitation, while communication and building mutual understanding are essential cornerstones of the creative process.

Limitation of co-creation

Co-creation as executed in this study involved a limited number of participants. Though extensive in-depth analysis was conducted, the insights are based on a relatively small number of participants, which might hinder acceptance of these findings by others within the organization. For example, market researchers might not trust the findings because they are not validated with a large number of respondents, as is common in market research. Therefore, in communicating the results, it is important to convey that their value is in the discovery of unmet user needs and inspiring new directions for innovations, rather than validating user needs the company already knew.

Co-creation may lead to innovative, new, and highly marketable ideas, but not all of these ideas are necessarily advantageous to the sustainability of a circular PSS. It may also not always be straightforward to find a solution to an identified need or challenge that benefits circularity and this may necessitate further research. The company's first reaction to the hygiene issue, for instance, was to consider a certificate of cleanliness guaranteeing the washing machine is 'as good as new' until they realized that this could be counterproductive: positive marketing communications (e.g. 'as good as new') on used or re-manufactured products tend to make consumers less – rather than more – favourable towards these product (Ackerman and Hu 2017; Mugge et al. 2018).

Conclusions

This case study shows that there are clear benefits to co-creating circular PSSs for both science and practice. Its key contribution to science is the model, which identifies tangible impacts of co-creation

and visualizes at what stages and levels co-creation can impact both the development of PSSs and a product manufacturer's shift along the servitization continuum.

We identified many benefits for the case study company. The co-creation sessions led to the development of value-adding services, e.g. with regard to repairs, allowing the development of attractive pricing and contract options and value propositions, and identifying potential user concerns and cultural differences. The uptake by the company revealed the positive impact co-creation had on the design process and the company itself; a broader support for the pay-per-wash concept and co-creation itself, as well as the development of employee's competencies, e.g. in empathic design. Co-creation was a positive disruptor in shifting ideas, for instance the shift from designing a dedicated PSS washing machine, to developing software adaptations which allow the entire washing machine portfolio to become 'PSS-ready'.

A success factor that greatly contributed to this impact was the product champion who arranged, facilitated and negotiated, and drove the innovation process. The communication medium was another success factor, in this case infographics, which successfully relayed the insights to the project team, and which were experienced as engaging to work with.

This research is unique in that it follows the company implementing the results of the co-creation sessions for a full year. Future research could expand on this work by also exploring the product launch and customer's use of the new PSS as well as strengthening co-creation methodology by investigating how to make the impacts of co-creation measurable. Furthermore, while there are clear benefits to implementing co-creation within circular product development, co-creation cannot answer all our pressing questions. For instance: What would it take to normalize (shared) access models in society, and what are the underlying values that impede this process? How can users be enticed to use a (long-lasting) product in an access model for as long as possible and also avoid the 'don't be gentle, it's a rental' conundrum?

In closing, co-creation is an advantageous approach that merits more use within the field of circular economy, though care should be taken when implementing the results to avoid effects that are counter-productive to circularity. In this regard, new ideas should to be weighed as to their effect on the overall circularity of the product so that PSSs can be developed that are both successful and fully circular.

NOTE

1. ReCiPSS is an H2020 EU project that includes a large-scale washing machine case study. Co-creation is used as a key strategy in the development and piloting of the PSS throughout the project.

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