

# Is Human-Centered Design Key To Product-Service Systems?

## A Reflection On 12 Case Studies

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## Extended abstract

Moving from selling standalone products to merging products with service offerings through product-service systems (PSS) has increasingly been touted as a means to significantly reduce production and consumption without compromising user needs. Estimates suggest PSS can provide up to 90% environmental impact improvements (i.e. CO<sub>2</sub> reduction, material, and energy savings) compared to traditional product sales (Tukker, 2004). In practice the potential for PSS to achieve such promises varies and depends on: 1) the types of products deployed within an offer (and the way they are designed); 2) use phase factors such as transportation and use intensity; and 3) contextual factors such as the energy mix (Sarasini et al., 2024). Despite the potential benefits of PSS, the adoption of PSS is still very limited due to both corporate and cultural challenges (Baines et al., 2007; Beuren, Gomes Ferreira & Cauchick Miguel, 2013; Wang et al., 2011).

To increase adoption, existing scholarship stresses the importance of basing the design of PSS on user needs (Annarelli, Battistella & Nonino, 2016; Barravecchia et al., 2021; Beuren, Gomes Ferreira & Cauchick Miguel, 2013) and developing offers that create value for customers (Annarelli, Battistella & Nonino, 2016; Baines et al., 2007; Wang et al., 2011). Moreover, several reviews on PSS literature conclude that users should be involved in the development process and play an integral role to ensure that designs match cultural conditions and fulfil individuals' needs (Baines et al., 2007; Beuren, Gomes Ferreira & Cauchick Miguel, 2013; Kurpiela & Teuteberg, 2022; Wang et al., 2011). This is also emphasized in the many tools and process models intended to support PSS development (Fernandes et al. 2020). However, the use and uptake of such tools is poorly understood and likely limited as tools developed in research may neglect the need for testing with end users (Bocken et al., 2019). Overall, the extent to which Human-Centered Design (HCD) (see Sanders & Stappers (2008)) is deployed when developing PSS is unclear.

This extended abstract reports on findings from an ongoing mixed-methods research study aimed at assessing the evidence base for the frequently highlighted claim that HCD is crucial for developing successful and impactful PSS, in terms of customer adoption, profitability and sustainability, for example. HCD covers traditional user-centered design approaches including ethnographic methods (Abrás, Maloney-Krichmar & Preece, 2004); participatory design approaches such as co-creation (Sanders & Stappers, 2008); and generative techniques (Sanders & Stappers, 2012). HCD methods have been discussed extensively in the design field and have proven useful for product design, service design, and business model innovation (see e.g., Alves, Fernandes & Raposo (2016) and Mao et al. (2005)). A growing literature base also describes benefits of engaging with users during development of circular offers and business models (see e.g., Bocken & Konietzko (2022), Lofthouse & Prendeville (2018), Santa-Maria, Vermeulen & Baumgartner (2022), Selvefors et al. (in press), and Selvefors et al. (2019)). However, the deployment of HCD in the field of PSS is relatively unexplored.

The aim of this extended abstract is to present findings from an ongoing study on this topic. We focus on an analysis of existing PSS case studies, which are used as initial data sources for learning about the role of HCD in PSS development. Four searches in the Scopus database were conducted with keyword combinations including the following: product-service system, PSS, collaborative consumption, sustainable business model, circular economy, library, rent\*, leas\*, co-creat\*, assess\*, eval\*, success, and case study. The searches resulted in 198 publications of which 12 case studies discussing the success of PSS in relation to PSS development were found relevant and chosen for analysis. The analysis initially sought to identify whether HCD methods were described and how methods had been applied in practice. The cases that highlighted HCD methods were also analysed in more detail to explore the impacts of HCD vis-à-vis success criteria such as PSS adoption.

Four papers (Annarelli, Battistella & Nonino, 2020; Åkesson et al., 2022; Bodenheimer, Schuler & Wilkening, 2022; Zhang et al., 2015) do not describe whether HCD methods were used for PSS development. However, they do state that there is value in considering user needs and engaging with potential users or customers during the development process. Six other papers highlight various ways that companies applied HCD to engage with their user base. Such activities included analysing user feedback to identify opportunities for improvements (Arrigo, 2021; Petersen & Riisberg, 2017); collecting data on usage to improve user experiences (Nyvall, Zobel & Mark-Herbert, 2023; Petersen & Riisberg, 2017; Ritch & Siddiqui, 2023); identifying user needs and customer types to customize solutions (Nyvall, Zobel & Mark-Herbert, 2023; Ritch & Siddiqui, 2023); and testing prototypes and early versions with users to identify opportunities for improvements (Nastase et al., 2021; Sumter, Bakker & Balkenende, 2018). Lastly, two papers (Tran & Park, 2016; van Dam, Sleswijk Visser & Bakker, 2021) present case studies in which the research team applied co-creation methods to explore their benefits for PSS development.

Our initial analysis suggests there are limited published case studies that describe how companies work with HCD methods when developing PSS. The studies that do discuss HCD methodologies suggest that traditional approaches, such as collecting data through feedback forms, surveys, and user testing, can contribute valuable input to PSS development. Co-creation was only discussed as part of researcher-initiated activities, but these cases suggest that co-creation can enhance the quality of the PSS and be an untapped source of innovation. However, our analysis on the benefits and drawbacks of different HCD methods is incomplete, and there appears to be a lack of research on which methods have a higher potential to support the development of successful PSS.

Given the limited sample size of our initial investigation, directions for future work include broadening the scope of the literature review. Additional case studies such as those drawing on innovation studies (Ceschin, 2013) and circular economy (Prendeville & Bocken, 2017) may complement this work. Bocken and Konietzko (2022), Bocken et al. (2024) and Selvefors et al. (in press) have investigated tools and practices deployed during sustainable, circular innovation processes (including HCD methods) but little is known about the impact of using HCD methods and tools in practice. Do such methods and tools lead to better user experiences? Do they help to mitigate the environmental impacts of PSS across the product life cycle?

Further investigation is needed to gain additional insight into both how companies work with different types of HCD methods and what benefits they provide for PSS development. Opportunities for future work hence include conducting new case studies to explore whether and how companies implement HCD in PSS development and to assess the link between use of HCD methods and PSS success, such as in terms of customer adoption and profitability. As part of the ongoing research study, the authors have begun compiling a database of global PSS initiatives and are currently investigating some of these initiatives to further explore the evidence of the benefits of HCD in PSS development.

## Keywords

Product-services systems, Human-centered design, User-centered design, Co-creation, Circular business models.

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