



A paradox approach to sustainable product-service systems

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ABSTRACT

A move towards the business model of product-service systems (PSS) holds the promise of changing customer behaviour in a more sustainable direction. While this promise of PSS to play a key role in business sustainability has long been recognised, so far, the realised sustainability benefits remain limited. This article sheds light on the reasons why PSS seem to struggle with delivering on their potential. It develops the argument that sustainable PSS are fraught with paradoxical tensions between their marketability and their potential to achieve substantive sustainability benefits. Applying a paradox lens, the article identifies six paradoxes inherent to sustainable PSS and argues that unlocking their full potential to achieve sustainability benefits requires a proactive approach to respond to these paradoxes.

1. Introduction

A transition towards the business model of product-service systems (PSS) holds the promise of changing customer behaviour in a more sustainable direction. PSS are the outcome of manufacturing firms transitioning from making products only to offering products with accompanying services. PSS operate on a continuum with products with some add-on services, on the one hand, and, fully customised customer solutions where the product is the add-on, on the other (Gebauer, Fleisch, and Friedli, 2005; Kohtamäki, Einola, and Rabetino, 2020). By offering products with customised services, firms have more influence over the ways in which customers use their products (Beuren, Gomes Ferreira, and Cauchick Miguel, 2013). For many products such as cars, boilers, etc., much of the adverse sustainability impact occurs in the usage phase. The more firms can control how customers use their products through the service component, the more they can make them use these in a more sustainable way. PSS can improve resource utilisation because they let firms extend the product lifetime by taking care of maintenance. Besides, keeping ownership of the products allows firms to recycle or reuse them, and improve their circularity (Baines et al., 2007; Reim, Parida, and Örtqvist, 2015; Tukker, 2004).

The PSS literature has shown, however, that PSS' sustainability benefits have been limited (Tukker, 2004). As Reim et al. (2015, p. 72) posit: "Most PSS studies take for granted that implementing PSS drives environmental benefits." Tukker (2004, p. 258) is cautiously optimistic:

"most PSSs will probably lead to some environmental improvements, or at least not worse environmental performance." Nonetheless, lower sustainability performance is a potential outcome, for instance when leasing products leads to wasteful use. Clearly, the promise of PSS to improve sustainability performance is up to debate. We posit that several paradoxes prevent PSS to generate sustainability benefits.

Adopting a paradox lens on business sustainability (Hahn, Figge, Pinkse, and Preuss, 2018), we argue that the main complexity of PSS generating sustainability benefits is that measures to make PSS attractive to customers are in a paradoxical relationship with measures that help optimise the sustainability benefits. The PSS literature focuses on measures to improve the marketability of PSS by making services attractive to customers. Firms need to develop a market orientation by identifying customer needs so that they can customise the services (Gebauer et al., 2005). The sustainability benefits are often assumed to occur once the PSS is in place rather than these being actively facilitated. As customer needs go beyond worries about sustainability alone, measures to improve PSS' marketability might create a conflict with measures to enhance sustainability outcomes. The question arises whether tensions in PSS between improving marketability and promoting sustainability outcomes might be resolvable or whether they are truly paradoxical and therefore impervious to a permanent resolution? This question is relevant because truly paradoxical tensions require specific responses to navigate the persistent tension between the two competing poles (Smith and Lewis, 2011).

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We develop the argument that sustainable PSS are fraught with paradoxical tensions between their marketability and their potential for substantive sustainability benefits. We identify three challenges – contracting, marketing, and involving – which lead to paradoxical tensions related to the difficulty to measure sustainability impacts, communicate these to customers, and get customers and stakeholders involved in the sustainable PSS business model, respectively. We argue that PSS' full potential for sustainability cannot be leveraged easily because these paradoxical tensions hinder firms' ability to address intractable sustainability issues such as biodiversity loss and climate change. We believe that PSS could be designed to better fulfil their sustainability potential. We offer suggestions how a deliberate attempt to design PSS while embracing these inherent paradoxical tensions could improve their potential to generate sustainability benefits.

2. Sustainability benefits of PSS

Within the larger field of business and sustainability, sustainable PSS resonate with the recent uptake of ideas around the circular economy and circular business models (Geissdoerfer, Savaget, Bocken, and Hulink, 2017; Linder and Williander, 2017). However, the business and sustainability literature has largely settled on the business case paradigm that stipulates, from a normative perspective, that business should only pursue efforts to address sustainability challenges if doing so offers opportunities to capture economic value (Siegel, 2009; Sundaram and Inkpen, 2004), and, from a strategic perspective, that proactive sustainability strategies offer financial gains (Carroll and Shabana, 2010; McWilliams and Siegel, 2011).

2.1. Tensions in business sustainability

Recently, scholars have devoted attention to the tensions inherent to firms' pursuit of sustainability goals (Gao and Bansal, 2013; Hahn, Figge, Pinkse, and Preuss, 2010; Hahn, Pinkse, Preuss, and Figge, 2015; Van der Byl and Slawinski, 2015). The promise that addressing sustainability will translate into business benefits may appear simplistic. For sustainability issues such as climate change, biodiversity loss, poverty alleviation, and equal opportunities, and their intricate interrelations and lagged long-term effects (Reid et al., 2010), tensions between sustainability goals at the societal and organisational level will be the rule rather than the exception (Hahn et al., 2018). Engaging with sustainability requires firms to embrace, not reject, tensions between business and sustainability goals by attending to both poles despite their conflicting relationship (Hahn, Preuss, Pinkse, and Figge, 2014). As Hahn, Pinkse, Preuss, and Figge (2016) argue, firms need to ambidextrously pursue moral sustainability initiatives, which seek to achieve sustainability benefits for their own sake, and instrumental sustainability initiatives, to reap business benefits. A growing body of empirical studies has shown evidence for the need to navigate tensions to achieve sustainability benefits (Preuss, Pinkse, Hahn, and Figge, 2021).

2.2. A paradox lens

Paradox theory provides a foundation for looking into tensions in business sustainability (Putnam, Fairhurst, and Banghart, 2016; Schad, Lewis, Raisch, and Smith, 2016; Smith and Lewis, 2011). Opposed to simple tensions which denote “opposite concepts or behaviors [that] push and pull against one another, like a rubber band that pushes and pulls back and forth” (Putnam, Myers, and Gailliard, 2014, p. 416), paradox describes situations with “persistent contradictions between interdependent elements” (Schad et al., 2016, p. 6). Paradox entails tensions between two opposing poles where these poles are interdependent, and are marked by persistence (Cunha and Clegg, 2018) and being “impervious to resolution” (Schad et al., 2016, p. 11). Paradoxes are salient elements of organisational life, in particular in situations marked by complexity, plurality, and change (Smith and Lewis, 2011).

A paradox lens has been applied to PSS. PSS scholars see maintaining efficiency in production and creating effectiveness in customised solutions as paradoxical (Dmitrijeva, Schroeder, Ziaee Bigdeli, and Baines, 2022; Kohtamäki et al., 2020). This paradoxical tension between production efficiency and customer effectiveness has spurred other tensions due to the need for different customer relationships, organisational structures, approaches to innovation, organisational identities, and performance measures (Gebauer et al., 2005; Kohtamäki et al., 2020; Tóth et al., 2022). The failure to manage such tensions has been considered key in explaining firms' limited success to increase revenues with servitisation (Gebauer et al., 2005; Kohtamäki et al., 2020). The business sustainability literature has analysed various tensions through a paradox lens, too, including temporal tensions (Slawinski and Bansal, 2015), spatial tensions (Slawinski, Winsor, Mazutis, Schouten, and Smith, 2019), professionals' identity tensions (Carollo and Guerici, 2018), and tensions in circular business models (Daddi, Ceglia, Bianchi, and de Barcellos, 2019).

Given the pervasiveness and persistence of organisational paradoxes, how organisations and decision makers respond to them is important. Whereas simple tensions can usually be solved with a compromise based on a contingency approach to identify the best mix of two competing demands, paradoxes defy simple responses (Smith and Lewis, 2011). Prior studies have identified responses to paradox that span from defensive to active responses (Jarzabkowski, Lê, and Van de Ven, 2013; Lewis, 2000). Through defensive responses firms seek immediate relief to avoid discomfort but only provide a temporary solution. With defensive responses firms deny or withdraw from the tension (Lewis, 2000). Due to the persistent nature of paradox, such responses do not remove tensions but spur further tensions (Jarzabkowski et al., 2013) and fuel vicious cycles (Lüscher and Lewis, 2008). Several studies have looked at the dark side of sustainability paradoxes by addressing how firms avoid them to protect their contested unsustainable business models (Ferns, Amaeshi, and Lambert, 2019; Iivonen, 2018; Pinkse, Hahn, and Figge, 2019).

With active responses firms accept and embrace paradoxical tensions (Clegg, da Cunha, and e Cunha, 2002; Lüscher and Lewis, 2008). Proactive responses are argued to portray paradoxical tensions “as an invitation to act” (Beech, Burns, de Caestecker, MacIntosh, and MacLean, 2004, p. 1327), enabling actors to see interrelations between and to attend to both poles, despite their contradictions (Smith, 2014). Proactive responses have been associated with desirable outcomes such as creativity (Miron-Spektor, Gino, and Argote, 2011) and innovativeness (Gebert, Boerner, and Kearney, 2010). In a sustainability context, embracing and navigating paradoxes have been related to positive outcomes such as corporate social performance (Hahn et al., 2016), long-term commitment to sustainability (Slawinski and Bansal, 2015), the success of hybrid organisations (Vallaster, Maon, Lindgreen, and Vanhamme, 2021), and effective corporate sustainability strategies (Joseph, Borland, Orlitzky, and Lindgreen, 2020).

Next, we apply a paradox lens to analyse sustainable PSS. We identify six paradoxes inherent to sustainable PSS and argue that unlocking the full potential of sustainable PSS to achieve sustainability benefits requires a proactive approach to these paradoxes.

3. Paradoxes of sustainable PSS

We identify and elaborate six paradoxical tensions that complicate PSSs' potential to generate sustainability benefits. To identify these tensions, we draw inspiration from Reim et al.'s (2015) review of PSS business models and tactics. They identify five different tactics – contracts, marketing, product and service design, networks, and sustainability – discussed in the PSS literature for how firms implement PSS. Rather than seeing sustainability as separate, we see it as transversal and put it at the core of our analysis to examine how the other four tactics facilitate or hinder PSS to generate sustainability benefits. We focus on three challenges – contracting, marketing, and involving – which relate

to measuring sustainability impacts, communicating these to customers, and getting customers and stakeholders involved, respectively. As Fig. 1 summarises, each challenge consists of two underlying, intertwined paradoxes.

3.1. Contracting: Paradoxes of measurement and commensurability

When firms transition towards PSS, they accept responsibility for products' sustainability impact in the usage phase (Baines et al., 2007), which leads to increased risk: not meeting sustainability targets depends on customer behaviour. The PSS literature discusses the contracting tactic to mitigate such risks (Reim et al., 2015). A firm leasing energy-intensive appliances can contract for the energy reductions it promises to customers. Firms increasingly offer carbon offsets with their products, too, which promise to offset CO₂ emissions generated from product use. Shell offers fleet customers the option to drive carbon neutral by offsetting CO₂ emissions of purchased fuel. Such contracts are complex because they rely on the correct measurement and monetisation of sustainability impacts. We posit that contracting for the responsibility to generate sustainability benefits leads to two paradoxes: measurability and commensuration.

The measurability paradox questions how to contract for what might be immeasurable. It captures the tension between the comprehensibility

and the accuracy of measuring the sustainability impacts that are both necessary for creating a market for PSS, such as energy services and carbon offsets, through contracting. Making such services attractive to customers requires that sustainability effects can be measured and communicated unambiguously and comprehensibly. On the sustainability side, measurement needs to capture the complexity of sustainability problems. However, sustainability is notoriously difficult to measure for several reasons: there is a lack of agreement on the correct method to measure social and environmental impact; the scale and scope of impact tend to be highly uncertain; and they are difficult to monitor due to the complexity of the supply chain. Hence, impact measurement needs to be both comprehensible and accurate, resulting in a paradoxical tension. The more contracting-based PSS lean towards simplified impact measures, the less they capture full sustainability impact, while leaning towards complex and accurate impact measures complicates the marketability of contracting-based PSS.

In the case of energy use and CO₂ emissions, measurement might be possible but complex. Calculating CO₂ emissions from fuel combustion rests upon assumptions about the chemical process and physical conditions. Measuring carbon offsets is also complicated because there are many methods such as investing in reforestation or renewable energy projects which are highly contested. With reforestation, there is no guarantee that emissions remain offset beyond the contract's duration.

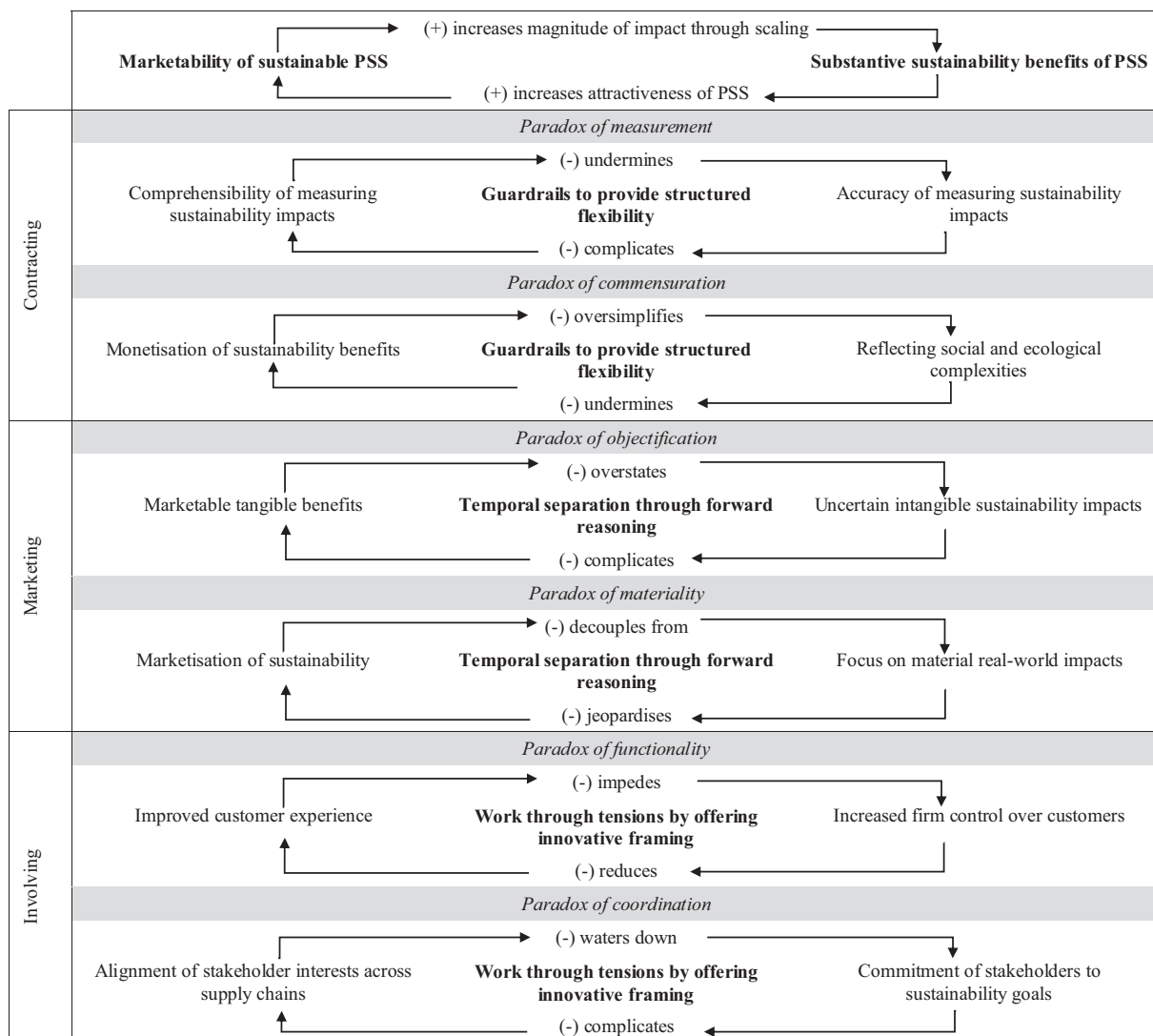


Fig. 1. Paradoxical tensions in sustainable PSS.

For plastic pollution and biodiversity loss measurement is even more difficult. Regarding plastic pollution, many factors are at play such as the chemical composition of the plastics and the difficulty to know how much gets into rivers and oceans. Regarding biodiversity loss, this captures all kinds of issues related to ecosystems, species and genes that are very difficult to measure with much accuracy (Panwar, Ober, and Pinkse, 2022). Measurability is also problematic in case of social issues. In the social entrepreneurship literature, there is a debate about the near-impossible task of measuring social impact. While social enterprises have experimented with different impact evaluation methods, each has its own flaws (Molecke and Pinkse, 2020, 2017). Measuring social impact assumes full knowledge of upstream and downstream activities, while the complexity of today's global supply chain defies having such knowledge.

The commensuration paradox is closely related to measurability. Commensuration refers to 'the transformation of qualitative relations into quantities on a common metric' (Levin and Espeland, 2002, p. 121). This paradox captures the tension between monetising sustainability benefits of PSS while still reflecting social and ecological complexities. Qualitative manifestations of social and environmental impact are often translated into quantitative measures. Greenhouse gas emissions are grouped together into CO₂-equivalent to allow for comparison (Kolk, Levy, and Pinkse, 2008). To contract for PSS, commensuration involves translating qualitative impacts into monetary terms. Commensuration is a political and institutional project where a monetary value is attached to sustainability impacts based on subjective preferences (Levin and Espeland, 2002). Commensuration is paradoxical: while the marketability of contracting-based PSS benefits from monetising sustainability, it tends to over-simplify ecological complexities. At the same time, reflecting complexities undermines monetisation.

The more PSS rely on monetising, the higher the risk of misrepresenting sustainability impacts. Restraining monetisation might capture sustainability impacts more accurately. Yet, it hampers widespread adoption of contracting-based PSS and creating larger-scale sustainability benefits. In the case of biodiversity, there has been much work on monetising ecosystem services to capture the societal benefits of well-functioning ecosystems (Winn and Pogutz, 2013). Considering biodiversity as ecosystem services takes a narrow view on ecosystems and putting a monetary value on ecosystem services is reductionist because it only considers their economic benefits. Within the field of social impact measurement similar projects have taken hold such as the social return on investment which facilitates the inclusion of social and environmental impact in financial accounts.

If the measurability and commensuration paradoxes are not addressed, the potential of PSS to generate sustainability benefits is significantly undermined. These paradoxes complicate the contracting required to allocate risks and responsibilities between a firm and its customers. Contracting appears straightforward for sustainability issues where impact is unambiguous, measurable, and observable. Most sustainability issues do not meet such standards, though. Not surprisingly, PSS' sustainability benefits are discussed mainly regarding energy efficiency and resource utilisation, only a subset of sustainability. These two paradoxes reflect the uneasy relationship between the push of markets to measure and monetise impact and the need for sustainability to take a holistic view of impact. Trying to tackle sustainability via PSS leads to the same problem as the win-win paradigm (Linder and Willander, 2017): only what can be measured and monetised with some certainty will be addressed (Hahn et al., 2014).

3.2. Marketing: Paradoxes of objectification and materiality

A key attribute of PSS business models is the additional value they offer to customers (Baines et al., 2007; Tukker, 2004). By adding services to products, PSS expand the value created for customers. Value no longer only derives from the product but also from add-on services (Gebauer et al., 2005; Kohtamäki et al., 2020). For sustainable PSS, the

additional value can be tangible and intangible (Tukker, 2004). Customers appreciate PSS' tangible value of lowering resource consumption and the associated costs. The intangible value of reduced social and environmental impacts that come without associated private benefits also forms an important PSS component, however, from a strict market perspective they represent positive externalities that cannot be easily objectified for customers. An example of such intangible value is a PSS delivering green power. Customers have more willingness to pay for green power based on the promise that it will contribute to making the electricity grid sustainable, while green electricity is not materially different from fossil-fuel-based electricity. The importance of intangible value for PSS leads to two paradoxes: objectification and materiality.

The objectification paradox captures the need for PSS to generate marketable tangible benefits from intangible and uncertain sustainability impacts, which are difficult to objectify for customers. For marketing communication, sustainability's intangible value needs to be objectified so that customers can relate to it (Pinkse and Bohnsack, 2021). However, many sustainability issues are complex and alien to the customers' daily experiences. Only when issues can be framed as relevant to people, such as health benefits or dangers of flooding, does it seem possible to make the intangible value more concrete. There is a paradoxical tension between tangible benefits and a related marketing message that customers can connect to, and the difficulty to capture complex and uncertain nature of sustainability impacts that defy clear objectification.

While PSS' sustainability benefits depend on both customer adoption and buy-in and an adequate reflection of sustainability benefits, leaning excessively towards either pole will undermine these. PSS lend themselves particularly for addressing issues people can relate to: those salient to a wide public with clear paybacks in the short run. But not all issues are easy to relate to and some take quite long to have observable impacts. In the Netherlands, there is an ongoing debate on excess nitrogen oxide emissions. To cut these, the Dutch government has made drastic interventions such as pausing construction projects, curtailing livestock, and reducing speed limits.¹ These interventions were contested, because public perception was that they harm the economy in the short run, while benefits of lower nitrogen oxide emissions remain ambiguous and reach critical thresholds in the longer run only. The difficulty to objectify sustainability benefits into concrete short-term value for the customer means that PSS cannot be applied as easily to issues where sustainability benefits accrue over longer time horizons or to a diffuse set of beneficiaries.

The materiality paradox is akin to the commensurability paradox above. The necessary marketisation of sustainability benefits leads to a decoupling from the material world (Bansal and Knox-Hayes, 2013), while focusing on physical sustainability impacts distracts from marketisation. PSS fit a wider trend of marketising sustainability. Without monetisation PSS are unlikely to be marketable, but their sustainability benefits are undermined if monetisation leads to a decoupling from material effects. This materiality paradox highlights that to be both marketable and create sustainability benefits, PSS need to attend to competing but interdependent demands. To tackle climate change, emissions trading and voluntary carbon markets have been used increasingly (Bumpus and Liverman, 2008). Carbon markets commoditise the environment with tradeable emissions allowances and carbon credits (Lovell, Bulkeley, and Liverman, 2009). While this process marketises sustainability benefits, temporal and spatial attributes of sustainability get lost in the process (Bansal and Knox-Hayes, 2013). When successful, marketisation leads to a financial market which is more liquid, the more traders use it. For the financial market to be attractive, financial traders start speculating and do arbitrage to make money. As unintended consequence, marketisation leads to a decoupling

¹ <https://www.theguardian.com/environment/2021/sep/09/netherlands-proposes-radical-plans-to-cut-livestock-numbers-by-almost-a-third>

of the financial market from physical real-world impacts (Bansal and Knox-Hayes, 2013). The market no longer considers the material impact of trading. Carbon trading has become attractive because it has led to a vibrant market where carbon offsets' intangible value is traded. The underlying idea is that carbon offsets are related to real-world reductions in GHG emissions. While the carbon market might be vibrant, much trading behaviour occurs to make instant profits without any scrutiny whether offsets lead to lower GHG emissions.

Going back to PSS, there is the risk that PSS become very successful in selling sustainability by offering a range of new services and customer solutions that make sustainability claims which bear no relation with material sustainability impacts such as a reduction in waste and emissions, thus leaning excessively towards the market pole of the materiality paradox. By contrast, excessive emphasis on the materiality of sustainability impacts jeopardises PSS' scaling potential. Here, the effective sustainability impacts of PSS that stay true to the material physical and ecological effects might remain limited because the business model will never grow beyond niche markets.

The objectification and materiality paradoxes are both central to the success of PSS to attribute and monetise intangible sustainability benefits. These paradoxes suggest that there is a need to make concrete unknown, or at least uncertain, sustainability benefits to garner customer interest by objectifying and monetising them. Yet, given the complex and uncertain nature of sustainability issues and the intangible benefits from addressing them, losing track of the material physical and ecological reality when objectifying and monetising benefits undermines the desired sustainability effects. Without objectification and monetisation, PSS might not scale up though, undermining the scale of sustainability benefits. Without adequate management of these two paradoxes, PSS are limited to salient and relatable sustainability issues. For more intractable issues such as nitrogen oxides, firms will struggle to translate sustainability benefits into an attractive value proposition. Consequently, the success of PSS aimed at sustainability services would not translate into a reduction in waste or emissions.

3.3. Involving: Paradoxes of functionality and coordination

Reim et al.'s (2015) tactics of product and service design and networks both refer to closely involving various stakeholders in PSS. Compared to traditional business models, PSS build a closer relationship with the customer and stakeholders within the supply chain (Beuren et al., 2013; Reim et al., 2015). Customer involvement no longer takes place only during the transaction and after-sales services but becomes a continuous process helping firms to have more insight into customer behaviour (Baines et al., 2007; Gebauer et al., 2005). Firms can also exert control over how customers use their product. Adding a digital layer to products, firms can continuously update and upgrade the customer experience (Tóth et al., 2022; Yoo, Boland Jr, Lyytinen, and Majchrzak, 2012). Increased control is a double-edged sword because the customer is more susceptible to a firm's whims which lead them to resist being involved in the PSS (Gebauer et al., 2005; Tóth et al., 2022). Moreover, the complex nature of supply chains complicates stakeholder involvement, particularly relevant for sustainability. Stakeholders that need to be involved to deliver sustainability services have private interests which a firm operating in a complex supply chain cannot fully control. PSS' need for involving customers and stakeholders leads to two paradoxes: functionality and coordination.

The functionality paradox captures the tension between the improved customer experience from add-on services or customer solutions and the firm's increased control over customers to prevent wasteful behaviour. PSS' services aim to bring additional value to the customer through continuous innovation (Beuren et al., 2013; Reim et al., 2015). While a product is rather static, services, especially if digital, are malleable (Tóth et al., 2022). While the service component adds new features and functionalities to a product, sustainability features are not always improving perceived functionality. With these features, firms try

to change customer behaviour in a more sustainable direction, which has been referred to as forced-functionality (Wever, Van Kuijk, and Boks, 2008). Customers are more limited in how they can use the product. Modern cars, especially electric vehicles, have features to promote eco-driving such as providing feedback on driving behaviour to improve fuel economy. When such features are optional, users tend to ignore the feedback, while enforcing them can lead to reduced driving pleasure from a lack of excess speeding, aggressive acceleration, and sporty driving style (Sanguinetti, Queen, Yee, and Akanesuvan, 2020).

The functionality paradox reflects this tension. Services must steer and restrict customer behaviour to achieve sustainability benefits. However, a firm's increased control over customers can limit functionality, hampering customer acceptance of services designed to generate sustainability benefits. These services can limit wasteful usage so that customers can no longer use the product at their will. Energy-efficient use of products typically translates into operating at lower power, limiting speed or capacity of an industrial process. The more a firm controls customer behaviour, the more it can be perceived as intrusive (Tromp, Hekkert, and Verbeek, 2011), also because it relies on increased remote monitoring (Tóth et al., 2022). PSS' sustainable functionality will only be delivered when a certain degree of 'forcing' takes place. Yet, such intrusiveness can lead customers to see PSS as unattractive because it diminishes the customer experience and the freedom in using the product.

The coordination paradox denotes the tension between the need to align myriad stakeholder interests throughout the supply chain (upstream and downstream) to generate the largest sustainability impact and secure all collaboration partners' commitment to ambitious sustainability goals. A PSS' proper functioning assumes that stakeholders that need involvement in the sustainable supply chain can be identified and aligned. Offering sustainability services requires upstream collaborations with new partners who are specialised in these services (Reim et al., 2015). A complex PSS value proposition implies that a firm works with various complementors that offer the additional services (Dattée, Alexy, and Autio, 2018). To deliver customer value, a firm relies on myriad partners all with their own interests in the PSS, which are not always aligned with sustainability. When interests are not sufficiently aligned, the partnership's viability is jeopardised and the potential sustainability benefits will not be achieved. By contrast, if partners settle on the lowest common denominator to stabilise the collaboration, sustainability goals may be watered down, undermining the achievement of substantive sustainability benefits.

The coordination paradox highlights the need to balance competing but interdependent demands of aligning different partner interests for sustainability and securing partners' commitment to ambitious sustainability goals. The current drive for net-zero has led to a plethora of consultants offering climate services. The reliability of these services and the methods used to deliver the promised GHG reductions are difficult to control and monitor. To have more control, firms must either vertically integrate with service suppliers or reduce the services they provide because there is a need for shorter lines with suppliers. The supply chain's complexity also leads to tensions related to coordination downstream in the supply chain. PSS rely on more involvement of customers whose behaviour must be monitored and directed (Gebauer et al., 2005). Customer involvement and commitment to sustainability goals will be difficult with highly atomised sets of customers with different sustainability-related preferences.

The functionality and coordination paradoxes both highlight a need for more involvement of customers and stakeholders throughout the supply chain that goes along with the need to coordinate diverging preferences and interests. However, the coordination of sustainability-related services can jeopardise PSS' sustainability benefits. PSS' functionality is inherently multi-dimensional and customers could perceive sustainability services as compromising their interest to use a product as they want. The need for coordination hampers implementing ambitious sustainability goals as firms have to coordinate and involve multiple

partners and customers to achieve sustainability benefits. Given the complexity of today's global supply chains, without the adequate management of functionality and coordination paradoxes, there is a high chance that a firm cannot reach into the supply chain with its PSS in a way that would allow for more coordination of stakeholders either upstream or downstream that could bring the greatest leverage in terms of sustainability benefits.

4. Outlook

In general, PSS tend to struggle in leveraging servitisation to deliver additional revenue (Gebauer et al., 2005) due to paradoxical tensions between maintaining efficiency in production and creating effectiveness in customised solutions (Dmitrijeva et al., 2022; Kohtamäki et al., 2020). In this article, we argue that *sustainable* PSS add another level of complexity to the paradoxical tensions PSS are already fraught with. Sustainable PSS not only raise the expectation of offering sustainability services that improve marketability through customised customer solutions but also of delivering substantive sustainability benefits with such services. When lacking marketability, sustainable PSS are unlikely to be adopted on a larger scale which limits the magnitude of potential sustainability benefits. Without fundamentally departing from currently unsustainable practices, sustainability benefits at the desired scale are unlikely to accrue. The success of sustainable PSS depends on a simultaneous pursuit of competing but interdependent orientations towards marketability and sustainability benefits.

The full potential of sustainable PSS can only be leveraged if the inherent paradoxes that we identified are managed adequately. This insight invites future research regarding strategies to address these paradoxes to deliver both marketable services *and* accompanying sustainability benefits, despite the underlying tensions. The management approaches and response strategies identified in the paradox literature offer useful starting points (Jarzabkowski et al., 2013; Lewis, 2000; Poole and Van de Ven, 1989). In the following, we offer some examples for promising avenues for future studies for addressing some of these six paradoxes (see bold part in Fig. 1).

Addressing the measurement and commensurability paradoxes requires striking a balance between the complexity of sustainability impacts and their translation into measures that are comprehensible for market actors. The necessary complexity reduction goes at the expense of reflecting the multidimensional and intricate nature of sustainability impacts. Recently, Smith and Besharov (2019) found that managing paradoxical demands benefits from “structured flexibility” where actors can adaptively manage competing demands by shifting between two poles within a range defined by stable guardrails. Such guardrails provide orientation and limits an excessive emphasis on one of the two poles. In the context of measuring sustainability impacts, recently the EU Taxonomy has established the rule that practices can be considered sustainable if they contribute to one of six predefined environmental objectives while doing no significant harm to the others. Establishing similar guardrails for the measurement and commensuration of sustainability benefits in contracting-based PSS may offer an adequate approach to address the paradoxical tensions that challenge this type of sustainable PSS. Such guardrails of not doing significant harm preclude a sole focus of PSS on sustainability impacts that can be measured and/or monetised at the cost of other impacts that are less measurable.

The objectification paradox in marketing-based sustainable PSS refers to the need to offer clear and tangible benefits to customers while sustainability benefits often accrue as intangible positive externalities for which customers have a limited willingness to pay. The challenge to address this paradox adequately lies in finding ways to offer customers a compelling marketing message for the PSS that delivers the intangible external sustainability benefits which are difficult to objectify. With their “applied forward reasoning” approach, Levin, Cashore, Bernstein, and Auld (2012) offer a promising approach to manage this paradox. Their argument suggests that interventions to address intricate

sustainability challenges should create path dependencies through schemes that stick with customers due to their attractiveness, even if they do not fully measure up to achieving sustainability benefits in the first place. Subsequently, these schemes in which customers get entrenched can be constrained to achieve more substantive sustainability benefits while offering no option for users to abandon the intervention due to path dependencies. This approach resonates with temporal separation strategies discussed in the paradox literature that suggest that competing but interdependent demands can be achieved by sequentially attending to each demand (Jarzabkowski et al., 2013; Poole and Van de Ven, 1989).

Finally, the functionality paradox translates into a tension between customers' preference for free choice over a product's functionality and the need to restrict the range of product usage choices to achieve sustainability benefits of PSS. Addressing this paradox may consist in excluding the option of the most harmful product use regarding sustainability, while offering a wider variation of choices of different sustainable product uses. Customers still feel they have choice and autonomy over product use which should support PSS adoption which helps to achieve sustainability benefits at a larger scale. Simultaneously, it avoids making harmful choices which support sustainability benefits without overly lowering the PSS' attractiveness. This response does not eliminate the paradox but offers a framing that enables firms to constructively work through tensions through innovative solutions to attend to both poles (Lüscher and Lewis, 2008).

To conclude, there is widespread realisation now that tackling such sustainability challenges as the climate emergency and biodiversity loss requires a fundamental change how we use and consume products. Through PSS, firms could have a major impact on decreasing wasteful behaviour by steering customers with services offered as part of the business model. This thinking nicely fits the idea that we should move towards buying experiences instead of products. While pushing for PSS to create sustainability benefits is laudable, our main message is that this endeavour is fraught with potential pitfalls. Highlighting six paradoxes, we show that the PSS' potential to deliver sustainability benefits is severely hampered by the (unintended) consequences of the marketisation of sustainability that PSS involve. For PSS to be marketable, sustainability goals might be watered down so that the sustainability benefits realised through PSS become marginal at best. Yet, excessively emphasising sustainability goals may undermine the scalability of PSS and reduce sustainability impacts. However, these paradoxes are not insurmountable for PSS to contribute to a sustainability transition. We argue that acknowledging and working through these paradoxes can lead to new ways of thinking that no longer fall victim to oversimplification of the marketisation of sustainability. By providing guardrails, restricted choice options, and applied forward reasoning, PSS can put customers on a more sustainable trajectory which might not yet deliver sustainability benefits to the fullest potential but do break with unsustainable customer behaviour and set the path towards more sustainable choices.

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