A FRAMEWORK FOR SUSTAINABLE VALUE CREATION IN PRODUCT-SERVICE SYSTEMS (PSS)

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ABSTRACT
Product-service systems (PSS) have received increasing attention as having the potential to meet customers' needs by combining products and services, decrease environmental impacts and provide business opportunities for industry. PSS has the potential to facilitate sustainable production and consumption, and the environmental sustainability of PSS is often highlighted as a driver for and a result of PSS. However, the social dimension and the new shared value created by PSS is not yet widely understood. In this paper, the concept of sustainable value creation in PSS is presented to explore the relationship between PSS and sustainable value. To support a better understanding of value in PSS, a framework for sustainable value creation is presented. The framework is based on the three core elements of PSS: product, service and system, and provides insight into the different elements for each core element as a focal point of business models. The proposed framework is illustrated by a case study of school furniture and learning environments in Denmark.

KEYWORDS
Product-service system (PSS), sustainable value creation, shared value, stakeholders, learning environments

1. INTRODUCTION

The manufacturing and consumption of products and services in industrial societies is responsible for significant impacts on the environment and the society (UNEP, 2010). New sustainable business models and product design strategies are developed to reduce or avoid these effects by decoupling economic growth from environmental and social degradation (Bocken et al., 2016, 2014; Ceschin and Gaziulusoy, 2016). One of these business models is product-service systems (PSS), which is defined as systems that *'consists of a mix of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling final customer needs'* (Tukker and Tischner, 2006). PSS consequently consists of three key elements, which is defined by Goedkoop et al. (1999) as:

1) *Product: a tangible commodity manufactured to be sold. It is capable of falling on your toes and of fulfilling a user's needs*
2) *Service: an activity (work) done for others with an economic value*
3) *System: a collection of elements including their relations*

This definition of system is not comprehensive for a system perspective, as it does not include the value created by the collection of elements. We therefore propose a new definition of system: *a collection of elements including their internal relations, value creation and relations to external elements.*

PSS are often heralded as resource-efficient solutions that can act as an effective instrument in a societal transition towards a circular economy (Tukker, 2013). One of the ways that PSS can function as such a tool is by the shift in incentives for companies to prolong the service life of products, which makes them more cost- and resource-effective (Tukker, 2013). The concept of servitization thus provides an opportunity for companies to obtain a competitive advantage and boost turnover. Companies have been increasingly exploring the potentials of servitization since the 1980s to improve business (Cavalieri and Pezzotta, 2012; Oliva and Kallenberg, 2003; Spring and Araujo, 2013; Ulaga and Loveland, 2014; Vandermerwe and Rada, 1988), thus making service innovation and service contracts a part of business strategies. The reasoning for servitization of manufacturing companies have remained remarkably unchanged; to capture new revenue streams, increase profitability and sustain a competitive advantage (Oliva and Kallenberg, 2003; Spring and Araujo, 2013; Ulaga and Loveland, 2014; Vandermerwe and Rada, 1988). However, the challenge for many companies have been to combine service and product offerings to provide hybrid solutions such as PSS (Kuijken et al., 2017; Ulaga and Loveland, 2014), thus challenging the uptake of new PSS in a

system perspective. This is due to both a lack of internal abilities in companies to design and market effective PSS, and a lack of understanding by customers of the value and opportunities provided by PSS, as it contradicts the current and dominant norm of ownership (Vezzoli et al., 2015).
While the concept of PSS is well described (Annarelli et al., 2016; Beuren et al., 2013; Boehm and Thomas, 2013; Tukker, 2013), the sustainable value creation related to PSS in a system perspective is not yet widely investigated and understood (Bocken et al., 2014; Kuijken et al., 2017). Furthermore, a profound understanding of the economic, environmental and social impact of PSS as well as of the diffusion of PSS is lacking (Annarelli et al., 2016). This includes the ability to identify, assess and communicate the value in use, which is offered by a PSS (Baines et al., 2007).
The purpose of this paper is thus to provide an understanding of the sustainable value creation within PSS and to explore the concept of sustainable PSS and the different values depending on the focal point of the solution (i.e. product, service or system centered view). This is illustrated through a case study of school furniture from the traditional perception of table and chairs as the interior design of classrooms towards innovative learning environments encompassing the different learning styles and needs of students (Mehlsen, 2011; Ricken, 2013). The potentials in a shift towards learning environments also provides new value opportunities for multiple stakeholders. This is a contribution to the research field on sustainable business models by providing a system perspective on value creation within PSS. The research is based on a review of PSS and value creation, and supported by a case study of school furniture in a Danish Municipality. The case consists of three different approaches to purchasing furniture for schools, with one approach represented by a new renting scheme for innovative learning environments for public schools, developed by a Danish furniture company.
The paper is structured as follows. Section 2 'Product-service systems (PSS)' reviews the current research within the field of PSS and focuses on the evolution of PSS definitions. The proposed framework is presented in Section 3 'Framework for categorizing Sustainable value', which combines knowledge from previous research in the PSS domain and value creation domain. The framework is then illustrated through a case study of school furniture and learning environments in Denmark in Section 4 'Case study of school furniture'. The paper ends with conclusions and further research perspectives in Section 5 'Conclusions'.

2. PRODUCT-SERVICE SYSTEMS (PSS)

The concept of PSS has gained increasing attention since the 1990's as an instrument to support a sustainable transition of society (Beuren et al., 2013; Kuijken et al., 2017; Tukker, 2013; Vezzoli et al., 2015). The potentials of offering integrated solution of products and services are plentiful and well-described in the current body of literature: companies gain a competitive advantage (Beuren et al., 2013; Kuijken et al., 2017; Tukker, 2013), product lifetime is prolonged (Tukker, 2004), user satisfaction is maximized (Tukker, 2013), product use is intensified or replaced by more efficient and innovative products (Reim et al., 2015), the perceived value of a customized solution increases (Kuijken et al., 2017), consumption of products is reduced (Beuren et al., 2013), support a sustainable development (Beuren et al., 2013; Kuijken et al., 2017), and the environmental impact of consumption is minimized (Mont, 2002). However, the uptake of PSS in industry is still limited, despite the aforementioned potentials (Baines et al., 2007; Kimita et al., 2015; Kuijken et al., 2017; Vezzoli et al., 2015).
PSS is a widely studied concept within literature, and due to that many definitions have risen since the end of 1990's, where one of most cited definition was presented by Goedkoop et al. (1999). *Table 1* provides an overview of a number of different definitions as well as main elements included in each definition. The elements of 'system approach', 'customer needs', 'environmental effect' is brought forth by Annarelli et al. (2016) as some of the main elements occurring in existing PSS definitions. The system approach in *Table 1* represents a traditional view of system as the combination of tangible products and intangible services (Annarelli et al., 2016; Tukker, 2004), while the element of value creation is added to represent our understanding of system in a broader sense with a focus on shared value creation for multiple stakeholders. In addition, the element of sustainability and network has been added to provide insight into the focus on these elements in existing definitions, as the purpose of this paper is to shed light on sustainable value creation in PSS.

Table 1 Overview PSS definitions, modified from (Annarelli et al., 2016).

Author(s)	Definition	Main elements in definition					
		System approach	Customer needs	Environmental effect	Sustainability	Network	Value creation
Goedkoop et al., 1999	A marketable set of product and services capable of jointly fulfilling a user's need. The PS system is provided either by a single company or by an alliance of companies. It can enclose products (or just one) plus additional services. It can enclose a service plus an additional product. Product and service can be equally important for the function fulfilment.	x	x				
Manzini et al., 2001	A business innovation strategy offering a marketable mix of products and services jointly capable of fulfilling clients' needs and/or wants - with higher added value and a smaller environmental impact as compared to an existing system or product.		x	x			x
Mont, 2002	PSS should be defined as a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models.	x	x	x		x	
Tukker, 2004	A system consisting of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs.	x	x				
Baines et al., 2007	A PSS can be thought of as a market proposition that extends the traditional functionality of a product by incorporating additional services. Here the emphasis is on the 'sale of use' rather than the 'sale of product'.		x				
Neely, 2008	A Product-Service System is an integrated product and service offering that delivers value in use.	x					x
Geng and Chu, 2012	Products and services are integrated and provided as whole set to fulfill customer's requirements, and the product/service ratio can vary in different customer using contexts.	x	x				
Boehm and Thomas, 2013	A Product-Service System (PSS) is an integrated bundle of products and service which aims at creating customer utility and generating value.	x	x				x
Reim et al., 2015	PSS are defined as a marketable set of products and services that are capable of jointly fulfilling customers' needs in an economical and sustainable manner.		x	x	x		
Vezzoli et al., 2015	An offer model providing an integrated mix of products and services that are together able to fulfil a particular customer demand (to deliver a 'unit of satisfaction'), based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the economic and competitive interest of the providers continuously seeks environmentally and socio-ethically beneficial new solutions.	x	x	x	x	x	x
Annarelli et al., 2016	PSS is a business model focused toward the provision of a marketable set of products and services, designed to be economically, socially and environmentally sustainable, with the final aim of fulfilling customer's needs.	x	x	x	x		

Although different definitions exist, the core of the concept remains the same: providing products and services that is able to fulfill final user's needs. The combination of products and services is thus essential to PSS. Some authors focus on the potential of PSS to reduce environmental impacts, while others put emphasis on the necessary networks for PSS. Some authors put emphasis on the value generated for the users through PSS, but these definitions focus on the specific end user of PSS. Only the most recent definitions include environmental, social and economic sustainability in the definition, which shows an increased focus on the potential of achieving sustainable development through PSS. However, the elements of value creation and more specially network is often missing. The value creation is mainly related to customers and not to society as such. In this paper, we want to address sustainable value creation in PSS, as this has not been the focal point of previous research. Several authors touch upon a broader notion of value for multiple stakeholders. However, this notion is often related to value creation for customers and suppliers (Xing et al., 2013), and mostly only centered on customer value (Kuijken et al., 2017). The network perspective of PSS is

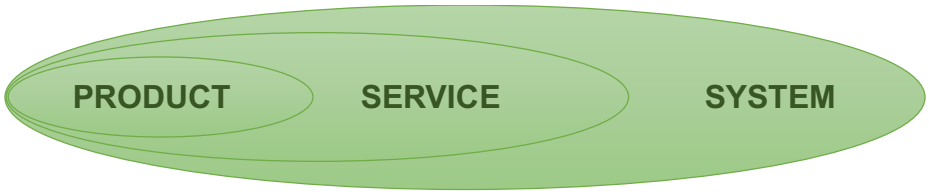
described by Medini and Boucher (2016), as they put emphasis to a multi-actor perspective in the value delivery networks of PSS. In other words, we aim at introducing a focus on shared value creation (Hart and Milstein, 2003; Porter and Kramer, 2011) and give more attention to the system perspective as more than just a combination of products and services, but as sustainable transition of society.

3. FRAMEWORK FOR CATEGORIZING SUSTAINABLE VALUE

For PSS to function effectively, added value for the customers must be provided by ensuring that the PSS deliver more customer benefit and value than if the products and services were available separately (Kuijken et al., 2017). The notion of value is highlighted by several researchers as an important part of a successful PSS (Baines et al., 2007; Kuijken et al., 2017; Lee et al., 2015; Medini and Boucher, 2016). The integration of service design and product design in PSS contributes to value creation for suppliers and for customers (Xing et al., 2013). In this paper, we elaborate on the concept of value creation in a systems perspective, as the system approach is highlighted by many as a key element in PSS. Mont (2002) argues that a system design approach is necessary for successful PSS design. However, the value created by a system approach for different stakeholders is not yet widely understood, and the perspectives related to shared value and a sustainable transition of society has not been investigated so far.

In order to propose a framework for categorizing sustainable value creation within PSS, the core elements of the concept will function as a framework. PSS can thus be seen as a three-step enlargement of value creation. Firstly, *product* represents the traditional transactional business model focused on product price, design and sale. Secondly, *service* represents the addition of service to existing product portfolio e.g. through service contracts. Lastly, *system* represents a system wide perception of creating value through new solutions, combining products and services, and in our understanding including a sustainable and shared value perspective. How the three concepts are interrelated is illustrated in *Figure 1.* Service thus encompass products, while system embodies both product and service.

Figure 1 Interrelation between the concepts of product, service and system in PSS



Improving the environmental performance and reducing environmental impacts of products have been the focal point for companies in many years. In order to achieve a competitive advantage, companies have expanded their business through servitization of the existing product portfolio (Ulaga and Loveland, 2014; Vandermerwe and Rada, 1988). This shift from selling product to servitized products also involves a life-cycle approach, as the addition of service requires consideration regarding the use of the product. Total cost of ownership (TCO) is a tool that can provide insight into the actual costs by including the sum of the costs related to the acquisition, possession, use and disposal of products and services (Ellram, 1995). Most TCO models follow a monetary approach, and when a value-based approach is applied the value items included are often expressed in monetary terms such as company reputation, products availability, downtime, etc. (Saccani et al., 2017). The system perspective on the combination of products and services thus represent a new perception of value creation as more than monetary, and for a broader range of stakeholders (Porter and Kramer, 2011). This perspective provides an opportunity to understand PSS as a tool to deliver shared value by addressing societal challenges. Shared value does not mean sharing the current value created by companies, but expanding the total pool of value for more stakeholders (Porter and Kramer, 2011). Companies will be able to create economic value by creating societal value. This enables a new understanding of which needs to meet, which products and services to offer and how to configure the value chain to deliver shared value. The complexity of sustainability needs to be understood in order to deliver sustainable and shared value (Hart and Milstein, 2003; Porter and Kramer, 2011).

To provide an understanding of the different value creating aspects within PSS, the concept of PSS has been broken down into three components, i.e. product, service and system to design a framework for understanding the value created within each element. The purpose is to illustrate the differences between traditional product sales; product sales including service; and lastly complete systems designed with a combination of products and services as well as with a broader value understanding. The needs to meet in each perspective broadens from the individual user to the society. The framework is presented in *Table 2*, displaying the differences between the product centered perspective, a service perspective and a system perspective.

Table 2 Framework for categorizing value creation for product, service and system perspectives.

	Product	**Service**	**System**
Definition	*tangible commodity manufactured to be sold* (Goedkoop et al., 1999)	*an activity (work) done for others with an economic value* (Goedkoop et al., 1999)	*a collection of elements including their internal relations, value creation and relations to external elements*
Focus	Price, quality, (eco)design, labelling	Maintenance, service, repair	Circularity, added value, solutions to societal problems
Sales model	Product sale (ownership)	Service contracts Servitization of existing products	Leasing Delivery of results
Value creation	Reduced purchase price, reduced environmental impacts, etc.	Reduced costs of ownership through preventive maintenance and repairs	Increased shared value for multiple stakeholders through systemic solutions
Primary value recipient(s)	Provider	Supplier, provider, customer (Supply chain)	Multiple stakeholders (network and society)

The value created in the different approaches broadens as the concept embodies more elements. Sustainable value creation in PSS necessitate a broader understanding of stakeholders, as the network and system approach to PSS expands the traditional focus on supplier, provider and direct user/customer. In the same way, companies' responsibility now exceeds their own boundaries and consequently include stakeholders, societies and sustainability issues (Sulkowski et al., 2017), companies providing PSS also expands their perception of value to include multiple stakeholders, society and sustainability issues. To design efficient PSS, the relevant stakeholders ought to be included in the design process (Morelli, 2006; Xing et al., 2013). Developing new PSS requires involvement of various stakeholders, which also requires a better understanding of their capabilities, practices and cultures (Kimita et al., 2015), in order to understand the value created for each stakeholder in the solution provided.

4. CASE STUDY OF SCHOOL FURNITURE IN DENMARK

To demonstrate the applicability of the framework in practice, school furniture is chosen as a case study. This particular case is chosen as an example of three different ways of providing furniture to public schools in Denmark. The case is based on a current transformation of public schools in the Municipality of Aalborg from traditional classrooms to innovative learning environments. This transformation is seen in the recent tender for furniture, in which circular economy is also an important assessment criteria (Aalborg Kommune, 2017). In addition, this case is also based on a new business model developed by a Danish furniture company. This business model is a new PSS, consisting of a renting scheme, where schools can rent learning environments that meet different learning needs.

Firstly, the *product*-oriented perspective represents sale of tables and chairs, which embodies a traditional 1:1 relationship in the classroom: 1 teacher per class, 1 table and 1 chair per student (Mehlsen, 2011). The value created in through this approach is limited to cost optimization for the provider, as no added value is created for other stakeholders in this model. In other words, this is the bare minimum for schools to acquire in relation to furniture.

The *service*-oriented approach adds secondly a service element to the existing products at the schools. In this scenario, the focus shifts from optimizing production costs to optimizing service life, which entails increased focus on repair and maintenance. The value created through this approach thus broadens to include suppliers of the furniture, as collaboration in the upstream supply chain is key for improving repair and maintenance of products supplied downstream.
The *system* perspective entails a different overall understanding of furniture in schools. Whereas the product- and service-oriented approaches entail traditional classroom settings, the system approach represents a new understanding of the actual needs of the users. This consequently require a closer collaboration between the provider and the teacher, students and schools to define needs. This process also prerequisites new roles in the collaboration, as the provider shall function as a consultant for learning as well as provider of innovative solutions, thusly providing complete interior environments that meet the learning and teaching needs and goals for each school. Providing these learning environments through a renting scheme can potentially create different values for multiple stakeholders, e.g.

- administration/management: no large initial investments, flexible interior solutions, improved space management,
- teachers: better opportunities to explore new didactic styles, fewer sick days due to less noise and disturbance in the classroom, improved working environment,
- students: improved learning, better study environment, increased feeling of ownership and responsibility of the furniture,
- technical service personal: easier cleaning, less time spent on repairing furniture = more time for other tasks,
- parents: improved well-being of their children,
- provider: better understanding of actual customer need, long-term relations to customers, design products for repair, maintenance, upgradeability etc.,
- society: improved learning, reaching overall learning goals, improved social wellbeing of staff and students, increased resource efficiency and circularity.

Table 3 demonstrates the application of the framework to this case, putting emphasis on the expanded pool of shared value created through a system perspective.

Table 3 Framework applied to the case of furniture for public schools in Denmark

	Product	**Service**	**System**
Definition	*tangible commodity manufactured to be sold* (Goedkoop et al., 1999)	*an activity done for others with an economic value* (Goedkoop et al., 1999)	*a collection of elements including their internal relations, value creation and relations to external elements*
Focus	Low price furniture, high competition and limited interaction with customers	Maintenance and repair of existing furniture	Learning environments that embody different learning styles and didactic needs
Sales model	Product sale of tables and chairs with little room for innovation	Service contracts on existing furniture, providing maintenance and repair Monthly payment	Leasing of learning environments with close collaboration between provider and user to identify needs Unit: 'learning environment for x students'
Value creation	Cost optimization for provider, lower production price of furniture	Reduced costs of ownership for schools through preventive maintenance and repairs, lower environmental impact through prolonging product life	Improved learning, better work environment, economic savings through leasing, fewer leave of absence due to illness, better space management, increased resource efficiency and circularity
Primary value recipient(s)	Provider	Supplier, provider, customer (Supply chain) Environment	Provider, suppliers, school administration, teachers, students, parents, society

5. CONCLUSIONS

Product-service systems (PSS) have the potential to support a sustainable development in societies. In addition to this, we argue that PSS in a system perspective enables increased shared value. The sustainable value creation related to PSS in a system perspective requires a nuanced understanding of the different customers of sustainable PSS. The value created will differ depending on the understanding of the customer in a broad sense. In the case study of learning environments for public schools in Denmark, the value created differs for each customer-group that are part of the solution. In this case, sustainable value is created for society, providing company, school administration, teachers, students and parents. For example, the expected value created for students is increased learning through improved wellbeing, reduced noise and furniture that accommodate for the individual learning style of each student. The research aimed to investigate the different customer groups and the sustainable value creation for each group in PSS, and application of the presented framework to the case indicate that PSS has potential to create value for different customer groups, when the concept of customer is expanded to include multiple stakeholders that may benefit from the PSS.

In this paper, we proposed a framework for categorizing PSS value creation based on a product, service or system perspective. As further research direction, additional empirical research into the different value aspects is recommended to deepen the understanding of shared value in PSS and to provide empirical validation of this framework.

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6. REFERENCES

Aalborg Kommune, 2017. *Udbudsbetingelser - Læringsmiljøer til folkeskoler og skolefritidsordninger i Aalborg Kommune.*

Annarelli, A., Battistella, C., Nonino, F., 2016. *Product service system: A conceptual framework from a systematic review*. J. Clean. Prod. 139, 1011–1032. doi:10.1016/j.jclepro.2016.08.061

Baines, T.S., Lightfoot, H.W., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J.R., Angus, J.P., Bastl, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., Michele, P., 2007. *State-of-the-art in product-service systems*. J. Eng. Manuf. 221, 1543–1552. doi:10.1243/09544054JEM858

Beuren, F.H., Gomes Ferreira, M.G., Cauchick Miguel, P.A., 2013. *Product-service systems: a literature review on integrated products and service*s. J. Clean. Prod. 47, 222–231. doi:10.1016/j.jclepro.2012.12.028

Bocken, N.M.P., Bakker, C., Pauw, I. De, 2016. *Product design and business model strategies for a circular economy*. J. Ind. Prod. Eng. 1015, 20. doi:10.1080/21681015.2016.1172124

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. *A literature and practice review to develop sustainable business model archetypes.* J. Clean. Prod. 65, 42–56. doi:10.1016/j.jclepro.2013.11.039

Boehm, M., Thomas, O., 2013. *Looking beyond the rim of one's teacup: a multidisciplinary literature review of Product-Service Systems in Information Systems, Business Management, and Engineering &* Design. J. Clean. Prod. 51, 245–260. doi:10.1016/j.jclepro.2013.01.019

Boucher, X., Brissaud, D., Shimomura, Y., 2016. *Design of sustainable product service systems and their value creation chains*. CIRP J. Manuf. Sci. Technol. doi:10.1016/j.cirpj.2016.09.005

Cavalieri, S., Pezzotta, G., 2012. *Product-service systems engineering: State of the art and research challenges.* Comput. Ind. doi:10.1016/j.compind.2012.02.006

Ceschin, F., Gaziulusoy, I., 2016. E*volution of design for sustainability: From product design to design for system innovations and transitions*. Des. Stud. 47, 118–163. doi:http://dx.doi.org/10.1016/j.destud.2016.09.002

Ellram, L.M., 1995. *Total cost of ownership: an analysis approach for purchasing*. Int. J. Phys. Distrib. Logist. Manag. 25, 4–23. doi:10.1108/09600039510099928

Geng, X., Chu, X., 2012. *A new importance–performance analysis approach for customer satisfaction evaluation supporting PSS design.* Expert Syst. Appl. 39, 1492–1502. doi:10.1016/j.eswa.2011.08.038

Goedkoop, M.J., Halen, C.J.G. V., Riele, H.R.M.T., Rommens, P.J.M., 1999. *Product Service systems - Ecological and Economic Basics*.

Hart, S.L., Milstein, M.B., 2003. *Creating sustainable value*. Acad. Manag. Exec. 17.

Kimita, K., Watanabe, K., Hara, T., Komoto, H., 2015. *Who Realizes a PSS?: An Organizational Framework for PSS Development.* Procedia CIRP 30, 372–377. doi:10.1016/j.procir.2015.02.143

Kuijken, B., Gemser, G., Wijnberg, N.M., 2017. *Effective product-service systems: A value-based framework.* Ind. Mark. Manag. 60, 33–41. doi:10.1016/j.indmarman.2016.04.013

Lee, S., Geum, Y., Lee, S., Park, Y., 2015. *Evaluating new concepts of PSS based on the customer value: Application of ANP and niche theory.* Expert Syst. Appl. 42, 4556–4566. doi:10.1016/j.eswa.2015.01.006

Manzini, E., Vezzoli, C., Clark, G., 2001. P*roduct-Service Systems. Using an Existing Concept as a New Approach to Sustainability.* J. Des. Res. 1. doi:10.1504/JDR.2001.009811

Medini, K., Boucher, X., 2016. *Configuration of Product-Service Systems value networks – Evidence from an innovative sector for sludge treatment.* CIRP J. Manuf. Sci. Technol. 12, 14–24. doi:10.1016/j.cirpj.2015.10.003

Mehlsen, C., 2011. *Farvel til fabriksundervisning, goddag til fremtidens fleksible læring.* Asterisk 6–11.

Mont, O.K., 2002. *Clarifying the concept of product-service system.* J. Clean. Prod. 10, 237–245. doi:10.1016/S0959-6526(01)00039-7

Morelli, N., 2006. *Developing new product service systems (PSS): methodologies and operational tools.* J. Clean. Prod. 14, 1495–1501. doi:10.1016/j.jclepro.2006.01.023

Neely, A., 2008. *Exploring the financial consequences of the servitization of manufacturing.* Oper. Manag. Res. 1, 103–118. doi:10.1007/s12063-009-0015-5

Oliva, R., Kallenberg, R., 2003. *Managing the transition from products to services.* Int. J. Serv. Ind. Manag. J. Bus. &amp Ind. Mark. Iss Int. J. Oper. & Prod. Manag. 14, 160–172.

Porter, M.E., Kramer, M.R., 2011. *Creating shared value.* Harv. Bus. Rev.

Reim, W., Parida, V., Ortqvist, D., 2015. *Product-Service Systems (PSS) business models and tactics - a systematic literature review.* J. Clean. Prod. 97, 61–75. doi:10.1016/j.jclepro.2014.07.003

Ricken, W., 2013. *Folkeskolens læringsrum - hvordan skiftende læringsaktiviteter kan understøttes af rum og indretning.*

Saccani, N., Perona, M., Bacchetti, A., 2017. *The total cost of ownership of durable consumer goods: A conceptual model and an empirical application.* Int. J. Prod. Econ. 183, 1–13. doi:10.1016/j.ijpe.2016.09.021

Spring, M., Araujo, L., 2013. *Beyond the service factory: Service innovation in manufacturing supply networks.* Ind. Mark. Manag. 42, 59–70. doi:10.1016/j.indmarman.2012.11.006

Sulkowski, A.J., Edwards, M., Freeman, R.E., 2017. *Shake Your Stakeholder: Firms Leading Engagement to Cocreate Sustainable Value.* Organ. Environ. 108602661772212. doi:10.1177/1086026617722129

Tukker, A., 2013. *Product services for a resource-efficient and circular economy - a review.* J. Clean. Prod. 97, 76–91. doi:10.1016/j.jclepro.2013.11.049

Tukker, A., 2004. *Eight Types of Product-Service System: Eight Ways to Sustainability? Experiencens From SusProNet.* Bus. Strateg. Environ. 260, 246–260. doi:10.1002/bse.414

Tukker, A., Tischner, U., 2006. *Product-services as a research field: past, present and future. Reflections from a decade of research.* J. Clean. Prod. 14, 1552–1556. doi:10.1016/j.jclepro.2006.01.022

Ulaga, W., Loveland, J.M., 2014. *Transitioning from product to service-led growth in manufacturing firms: Emergent challenges in selecting and managing the industrial sales force*. Ind. Mark. Manag. 43, 113–125. doi:10.1016/j.indmarman.2013.08.006

UNEP, 2010. *Assessing the Impacts of Consumption and Production: Priority Products and Materials.*

Vandermerwe, S., Rada, J., 1988. *Servitization of business: Adding value by adding services.* Eur. Manag. J. 6, 314–324. doi:10.1016/0263-2373(88)90033-3

Vezzoli, C., Ceschin, F., Carel, J., Kohtala, C., 2015. *New design challenges to widely implement "Sustainable Product Service Systems."* J. Clean. Prod. 97, 1–12. doi:10.1016/j.jclepro.2015.02.061

Xing, K., Wang, H.-F., Qian, W., 2013. *A sustainability-oriented multi-dimensional value assessment model for product-service development.* Int. J. Prod. Res. 51, 5908–5933. doi:10.1080/00207543.2013.810349