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Accelerating the progress towards
the 2030 SDGs in times of crisis

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Welcome Message by the Conference Chairs

This summer was a memorable experience for us at Mid Sweden University, having the opportunity to organize and host the 27th annual conference of the International Sustainable Development Research Society – ISDRS. We were proud to accommodate over 400 research presentations from 47 countries around the world, all of which engaging in the important endeavour of creating more knowledge to make our world a more sustainable one.

This document constitutes the published Proceedings of the conference. The volume contains abstracts, full papers and posters accepted after a rigid review process. They were selected for publication in the proceedings after a double-blind review process consisting of two stages, starting with acceptance of an abstract for either oral or poster presentation, further the opportunity to submit a full paper which was again peer reviewed.

Without the help of many hands this achievement would not have been possible. First of all, we would like to express our thankfulness to all the engaged reviewers which invested their private time to secure the highest scientific excellence and soundness. The review procedure was made possible through the support by the organizing team consisting of the conference manager Inger Axbrink, as well as Karin Knobloch, Richard Zaring, Elena Paschali and Matilda Eliasson. The digital conference itself had not been possible to organize without our IT support and the large number of students and volunteers, supporting the different sessions of the event.

The major effort of compiling and organizing all documents for the proceedings and producing an accessible graphic design was made by Matilda Eliasson supported by Karin Knobloch, Inger Axbrink and Catrin Johansson.

The main contribution of the proceedings is of course originating from the numerous authors. We express our gratitude in this way to you. Without your dedication and effort the work on this volume would not even have been started. We sincerely hope that the knowledge collected here will continue to make a difference and inspire towards enhanced efforts for transforming our societies in a more sustainable direction.

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A Case Study Analysis of the Furniture System From Sustainable Product-Service System Design Perspective

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Abstract

Studies on design for sustainability indicate that the concept of Sustainable Product-Service System (S.PSS) is a promising approach to bring radical changes in the production and consumption system with environmental, socio-ethical and economic benefits. The furniture system has been recently identified as one of the key sectors that should be addressed and improved for environmental sustainability and economic prosperity in the Circular Economy Action Plan (European Commission, 2020). In this respect, this paper presents a case study research aiming to explore and characterise the offer model of S.PSS when applied to the furniture sector as a promising win-win approach towards sustainability. The result indicates that applying S.PSS in the furniture sector can bring win-win benefits for a low environmental impact and a high economic value, even though with some peculiarities compared to the known general win-win S.PSS economic and environmental benefits. Some reflections are given concerning this approach in the socio-economic crisis taken by the Covid-19, which is made around the opportunities that S.PSS applied to furniture can extend the access to high quality and well-designed furniture to even low-income individuals and entrepreneurs.

Keywords: Sustainable Product-Service System, furniture system, Design for Sustainability, system innovation, Life Cycle Design

1. Introduction of the furniture sector's environmental impacts and possible solutions

The furniture production and consumption system is a resources intensive sector with high input and output related environmental impacts. Each year, around 42 million tons of furniture are produced, of which 57% are wood made furniture, 20% are upholstered furniture, 12% are metal made furniture, etc. (Tomaselli *et al.*, 2014; Forrest *et al.*, 2017). This means vast environmental impacts caused by the furniture sector in resources input and waste emission. As

a result, furniture has been recently identified as one of the key sectors that should be addressed and improved for more sustainable development (European Commission, 2020).

These negative environmental impacts of the production and consumption system accelerated research on the causes and solutions to these problems. Moreover, it has become a necessity to take radical steps towards sustainability in a systematic way. Former proposed method for product innovation, specifically environmental sustainability products design (even known as Life Cycle Design, LCD), is crucial to improve products' environmental performance concerning the life cycle processes (Vezzoli, 2018; Ceschin and Gaziulusoy, 2019). However, based on the production and sale of products in traditional business logic, manufacturers are usually not economically interested in optimising the sustainability along the product's life cycle, for example, extending product lifespan (Manzini *et al.*, 2003). From these aspects, it is necessary to move from product innovation to a more systematic approach. Researchers underline system innovations, which mean production processes and artefacts, patterns of consumption and access to goods and services are all under discussion (Brezet, 1997; Adams *et al.*, 2015; Manzini, 2002). In this aspect, Sustainable Product-Service System (S.PSS) is a promising one (Manzini, 2002; Tukker, 2004; Vezzoli *et al.*, 2014; Vezzoli *et al.*, 2021; European Commission, 2020). The definition of a S.PSS is “an offer model providing an integrated mix of products and services that are together able to fulfil a particular customer/user demand (to deliver a “unit of satisfaction”), based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the ownership of the product/s and/or the life cycle services costs/responsibilities remain with the provider/s, so that the same provider/s continuously seek/s environmentally and/or socio-ethically beneficial new solutions, with economic benefits” (Vezzoli *et al.*, 2021).

The research hypothesis of this paper, described in chapter 1, is that S.PSS for the furniture system could bring win-win benefits for environmental sustainability, economic prosperity and social cohesion with its own peculiarities.

The paper describes the S.PSS's general win-win benefits in chapter 2. Chapter 3 states the method for the case study; Chapter 4 describes the detailed information of a representative furniture S.PSS case and a cross-case analysis of 8 furniture S.PSS cases. In Chapter 5, the

paper presents the results interpretation of the case study analysis: furniture specific S.PSS types, S.PSS for furniture characteristics and the win-win benefits of S.PSS for furniture. Chapter 6 gives some reflections to overcome cases' limits and barriers. A special attention is given to the Covid-19 pandemic crisis. Chapter 7 summarises the main findings of this research and proposes steps for future research.

2. S.PSS general win-win benefits

Some authors (Vezzoli et al., 2021) proposed six win-win benefits of S.PSS. When products ownership and/or the economic responsibility for the life cycle performance remain with the providers (producers) who sells a unit of satisfaction rather than (only) the product, the providers (producers) have direct economic and competitive interest to reduce the products' and/or the services' environmental impacts through design and development. In other words, an S.PSS producer/provider is economically interested in design for 1) Product lifespan extension; 2) Product use intensification; 3) Resources (materials and energy) consumption minimisation; 4) Resources renewability/biocompatibility; 5) Material life extension (recycling, energy recovery, compost); 6) Toxicity/harmfulness minimisation.

3. Method for Case Study Analysis

The theory about the application of S.PSS in sustainable furniture design is quite limited. Some proposed furniture PSSs are not necessarily sustainable. The Case study method is selected in this research as coherent for studying new areas and issues where little theory is available (Eisenhardt, 1989; Yin, 2014).

Since evidence from multiple case studies is often considered more robust (Herriott and Firestone, 1983), multiple case studies are conducted in this paper. Selection criteria for cases and information analysis format are defined. Eight furniture S.PSS cases have been deeply analysed. Then a cross-case analysis is conducted to verify similarities and differences of S.PSS offer models of cases.

3.1 Aim and objectives of case study analysis

This case study analysis aims to verify and characterise S.PSS's win-win economic and environmental benefits into the furniture systems. In particular, verify whether and under what condition applying the S.PSS approaches to furniture design and offer makes the provider economically interested in improving furniture's environmental performance.

3.2 Collection and Cases selection criteria

This case study research of S.PSS applied to furniture is made over literature review and desk research. At first, a literature review is conducted with keywords 'furniture' or 'furniture design'; 'sustainable' or 'sustainability' or 'design for sustainability' or 'Product-service system'; 'case study' or 'case analysis' or 'case' with the google scholar tool to search best furniture cases. Then, desk research is conducted over three European Union-funded furniture projects, three research institutions' websites, more than 42 furniture companies' websites and five online interviews (or videos).

Based on the literature review and desk research, 22 sustainable furniture PSS cases come from 15 scientific papers, one book, one furniture project (Katch-e¹), three research institutions (LeNS network⁴, Ellen Macarthur Foundation² and Wrap³). All these cases are coherent with the general definition of the Sustainable Product-Service System (already presented in the introduction chapter). At last, eight sustainable furniture PSS design cases are selected as the best cases for this paper.

3.3 Analysis of cases

A case study format (see figure 1) is designed to collect and analyse case information, including the offered furniture products and services (i.e. the satisfaction unit), stakeholder configuration, sustainable benefits, etc. Specifically, the case study format is structured in the following sections:

¹ <https://www.katche.eu/>

² <https://www.ellenmacarthurfoundation.org/>

³ <https://wrap.org.uk/>

- General information of the project including brand, location, contacts, start year, project state, video (interview or introduction), source of case's information;
- Furniture analysis: (i) furniture characteristics including category, main materials and life cycle design strategies (i.e. furniture use extension/intensification, material consumption reduction for furniture, material life extension for furniture, toxicity reduction for furniture, energy consumption reduction for furniture, resources conservation/biocompatibility for furniture). (ii) furniture description. (iii) sustainable benefits;
- Furniture PSS analysis: (i) System characteristics including providers, customer, S.PSS type, satisfaction unit, offered products, offered services; ownership of products and payment methods. (ii) System description. (iii) Sustainable benefits of the system, including environmental benefits, socio-ethical benefits and economic benefits. (iv) stakeholders interaction showed with system map (developed by the LeNs network⁴, see figure 2);
- Limits and barriers of the system (if there are);
- Pictures to show products and systems.



Figure 1. Case study format

3.4 Cross-case analysis

⁴ <http://www.lens-international.org/>

After analysing each case, cross cases analysis is conducted. The aim is to compare the S.PSS for furniture configuration, satisfaction unit, offered products & ownership, offered service & provider, payment method and sustainable win-win benefits.

4. The outcome of case study analysis

Eight cases are analysed according to the case study format. All cases’ information has been recorded in LeNS network⁴. The following part recorded one representative S.PSS for furniture case to show how cases are analysed.

4.1 An example of furniture S.PSS cases - Furniture as a Service (GISPEN, the Netherland)

4.1.1 General information

Brand name	-Gispen
Producer/provider /alliance of providers	-Gispen
Company location	-The Netherland
E-mail	- info@gispen.nl
Website	- https://www.gispen.com/en/
Start (year)	-1916
State	-ongoing
Link to video	- https://www.youtube.com/watch?v=XxQwZtVGu-k
Source of information	- KATCHE project, (Bosch et al., 2017), (Pergande et al., 2012), (Zancul et al., 2011)

4.1.2 Furniture products analysis

i) Furniture characteristic

Furniture series (name):	Triennial seats
category	- chair
Main materials	-steel, textile, wood, foam
LCD strategies:	
Furniture use extension/ intensification	-use standard components and modular structure; design for easy disassembly;
Material consumption reduction	-none
Material Life Extension for furniture	-mono-material strategy; design for easy disassembly
Toxicity reduction for furniture	-none
Energy Consumption Reduction for furniture	-none
Resources conservation/biocompatibility	-none

ii) Short description of furniture products

All Gispen’s furniture is suitable for FaaS, especially the modular collections, like Triennial seats (see figure 4). The Triennial seat is manufactured from 75% standard components universal for other furniture groups. For example, the backrest of a chair can be used for a bar stool. The design increases the usability of each component in future life cycles. The series is designed for easy disassembly. The backrest can be replaced or swapped on-site by one person within 10 minutes without causing any damages due to one screw connection. The textile cover is held by a zipper, which is easily upgraded on-site. Material blends are avoided, the frame (steel) and the cover (fabric) are detachable from the seat (wood and foam).

iii) Characteristics of the reduction of environmental impacts

The furniture is designed for disassembly, which could extend the lifespan due to possible repair and upgrade. Design for disassembly and mono-material design could support materials life extension for further recycling.

4.1.3 Furniture Product-Service System analysis

i) System characteristics

System configuration:	B2B or B2C
Provider/s (role)	-Gispen
customer/s (type)	-business or individual
S.PSS characteristics:	
Type of S.PSS	-result-oriented
Unit of satisfaction	-users have access to well design furniture and all-inclusive life cycle services
Offered product/s (related producer/s)	-office furniture
Ownership of the offered product/s	-Gispen
Offered service/s (related supplier/s)	- delivery, installation, maintenance (annual check-ups, regular cleaning), repair, upgrade, replacement and reconfiguration (when the users’ needs change), take back and so on.
Access payment	-pay per month

ii) System description

Gispen is an office furniture manufacturer and provider that offers a ‘Furniture as a service (FaaS)’ solution (see figure 3) to users. FaaS is a subscription which leases office furniture and services with a fixed monthly fee. Gispen keeps the ownership and provides well-designed furniture (suitable for refurbishing and remade) with all-inclusive services of delivery, installation, maintenance (annual check-ups, regular cleaning), repair, upgrade, replacement and reconfiguration (when the users’ needs change), take back and so on. The stakeholder

interaction is shown in figure 2. Customers pay per period of use which avoids costly fees for purchasing and services.

iii) Sustainable benefits of the system

Since the ownership is retained by Gispén, who gets paid per month, the longer the furniture last, the more benefits for Gispén, so it is economically beneficial for Gispén to design furniture for life extension. The more the materials are recycled, the less cost of purchasing new materials, so it is economically beneficial for Gispén to design for material life extension.

4.1.4 System map

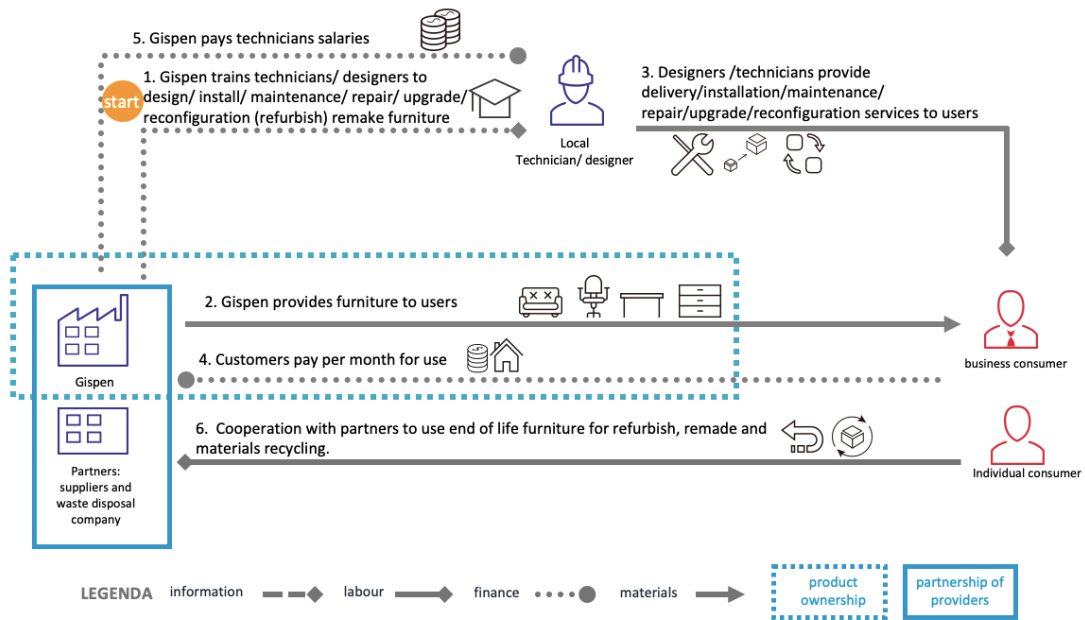


Figure 2. Stakeholders interaction for Gispén case (system map)

4.1.5 Pictures

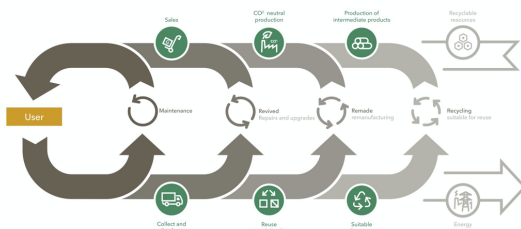


Figure 3. Furniture as a service



Figure 4. modular Triennial seat

4.2 Cross cases analysis

The cross-case analysis is shown in table 1.

Table 1. Cross analysis of eight S.PSS for furniture cases

Cases	provider	S.PSS types	Satisfaction unit		payment	ownership	Sustainable potential (environmental)furniture
			Products and characteristics	service			
FAAS	Gispen (the Netherland)	Result-oriented	Office furniture (modular, easy disassembly; mono-material for each component)	All-inclusive service: delivery, installation, maintenance, repair, upgrade, replacement, reconfiguration, take back.	Pay per month	The provider (Gispen)	i) Furniture life extension; ii) Material life extension
Take back service	Rype Office (UK)	Product-oriented	Office furniture (recycled/recyclable material, remade component)	Office layout and interior design, delivery and installation, take-back service	Pay a fixed fee for furniture and services	The customer	i) Furniture life extension; ii) Material life extension; iii) Resources renewability
Enable users for ergonomic needs	BMA (Norway)	Care-oriented	Ergonomic chair (modular structure, designed for disassembly)	Customised ergonomic sitting services: personal instruction (through tools and app), technical maintenance and cleaning services	Pay per period	The provider (BMA)	i) Furniture life extension; ii)Material life extension
Workplace sharing	Regus (Italy)	Result-oriented	Office furniture and supporting equipment	All-inclusive service: installation, maintenance, repair, upgrade, replacement, reconfiguration, and end-of-life treatment.	Pay per period	The provider (Regus)	i) Furniture use extension; ii) furniture use intensification iii) Resources (materials and energy) consumption minimisation; iv) Resources renewability
On-site assemble	IKEA (Sweden)	Product-oriented	Household furniture (flat packed, easy assembly and disassembly)	Service (video and text instruction) for on-site assembly, design service	Pay a fixed fee for furniture and services	The customer	i) Energy consumption reduction (during transportation)
Production based on pre-determined demands	Shangpin Home (China)	Product-oriented	Household furniture (modular furniture)	Customised design, delivery and installation	Pay a fixed fee for furniture and services	The customer	i) Resources (materials and energy) consumption minimisation
Cohousing	Cohousing (Italy)	Result-oriented	Household furniture and equipment	All-inclusive service: installation, maintenance, repair, upgrade, replacement, reconfiguration and end-of-life treatment.	Pay per period	The provider (cohousing)	i) Furniture use extension; ii) furniture use intensification; iii) Resources (materials and energy) consumption minimisation; iv) Resources renewability
Facilitating locally made/well-designed furniture	Open Desk (UK)	Product-oriented	Office furniture (local produced)	access to furniture design, connection to local craftsman	Pay a fixed fee for furniture and services	The customer	i) Resources (materials and energy) consumption minimisation; ii) Resources renewability

5. Results Interpretation: a refined definition and classification for S.PSS when applied to Furniture systems

5.1 Classification of S.PSS for furniture

Many researchers (Manzini *et al.*, 2003; Tukker, 2004; Vezzoli, 2007; UNEP and Delft University of Technology, 2017) classified PSSs into three categories: product-oriented PSS, use-oriented PSS and result-oriented PSS. When analysing former cases, it emerges that a refined classification for furniture S.PSS is needed to well describe different offers in the furniture sector. The type of S.PSS for furniture is thus being redefined as:

- *Product-oriented S.PSS for furniture* is ‘S.PSS adding value to the furniture’s life cycle’. To be specific, a company/organisation (an alliance of companies/organisations) provides furniture and additional all-inclusive services, i.e. design, maintenance, repair, upgrading, substitution, reconfiguration and furniture end-of-life treatment, etc., to guarantee life cycle environmental performance of the furniture which is sold to the customer. The customer owns the furniture, but the responsibility is reduced during use and end of life stages, and pays all-inclusive the furniture with additional services, like the Rype office take back service case.
- *Care-oriented S.PSS for furniture* could be defined as ‘S.PSS enabling furniture care platforms for customers’. To be specific, a company/organisation (an alliance of companies/organisations) provides access to furniture and/or furniture care tools with support services, enabling customers to care furniture, e.g. customers are enabled to care for design, delivery, installation, adjustment, maintenance, repair, upgrading, substitution and reconfiguration, etc. In this case, the customer does not own the furniture and/or furniture care tools but operates them to obtain a specific furniture use/care ‘satisfaction’. She/he pays per use of the furniture and/or furniture care tools, like the BMA case.
- *Result-oriented S.PSS for furniture* could be defined as ‘S.PSS providing furniture and full services to customers’. To be specific, a company/organisation (an alliance of companies/organisations) provides access to furniture, with all-inclusive life cycle services, e.g. furniture/interior/layout design, delivery, installation, maintenance, repair, upgrading, substitution, reconfiguration and end-of-life treatment, etc. The customer does not own the furniture. The provider carries out life cycle services, being paid per satisfaction unit. Like the Gispen/Regus case.

Table2. The comparison among different types of S.PSS for furniture

	Product-oriented S.PSS for furniture	Care-oriented S.PSS for furniture	Result-oriented S.PSS for furniture
Product	Furniture	Furniture and tools (and/or platform)	Furniture
Services	All-inclusive additional services	Enabling life cycle services	Life cycle full services
Ownership	Customer	Provider(s)	Provider(s)

Payment	Pay for furniture and all-inclusive additional services	Pay per access to furniture and enabling life cycle services	Pay per access to furniture and life cycle services
Examples	i) Additional take back service (Rype Office); ii) On-site assembly (IKEA); iii) Production based on pre-determined demand (Shangpin home); iv) Platform facilitate locally made furniture (open desk)	i) Enable users for ergonomics needs/Leasing (BMA)	i) Co-living; ii) Co-working; iii) furniture as a service/leasing (Gispen)

5.2 S.PSS for furniture refined definition

For what we have analysed and proposed in previous chapters, a refined definition of S.PSS could be given when applied to furniture: “S.PSS for furniture is an offer model providing an integrated mix of furniture and services that are together able to fulfil a particular customer/user demand (to deliver a “unit of satisfaction”), based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the ownership of the furniture and/or the life cycle services costs/responsibilities remain with the provider/s, so that the same provider/s continuously seek/s environmentally and/or socio-ethically beneficial new solutions, with economic benefits” (adopted from Vezzoli, et al., 2021).

5.3 Sustainable Furniture Product-Service System environmental and economic win-win benefits

5.3.1 S.PSS for furniture facilitates furniture use extension

As far as S.PSS for furniture provider is offering the furniture, retaining the ownership and being paid per satisfaction unit, or offering all-inclusive furniture with its maintenance, repair, upgrade, reconfiguration, substitution and end-of-life treatment, the longer the furniture or its components last (environmental benefits), the more the furniture producer/provider avoids or postpones the disposal costs plus the costs of pre-production, production and distribution of new furniture substituting the one disposed of (economic benefits), see figure 5. Hence, the furniture producer/provider is driven by economic interests to design for lifespan extension of furniture by applying furniture LCD strategies, including: facilitating furniture maintenance, facilitating furniture upgrading and adaptation, designing furniture for reliability, facilitating/enabling furniture reuse and remanufacturing or designing for disassembly.

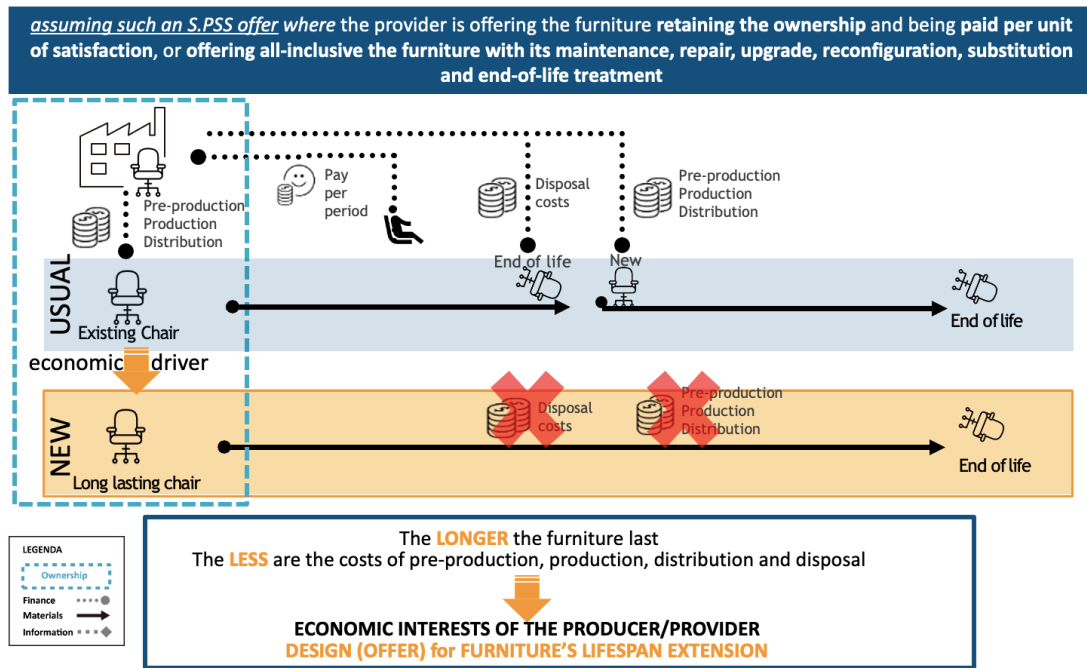


Figure 5. the win-win benefits of S.PSS for furniture (furniture life extension)

5.3.2 S.PSS for furniture facilitates furniture use intensification

As far as the S.PSS for furniture provider sells a shared use of furniture to various users, the more intensively the furniture is used (environmental benefits), the higher the profit (economic benefits). Hence, the furniture producer/provider is driven by economic interests to intensify furniture use. See

figure 6.

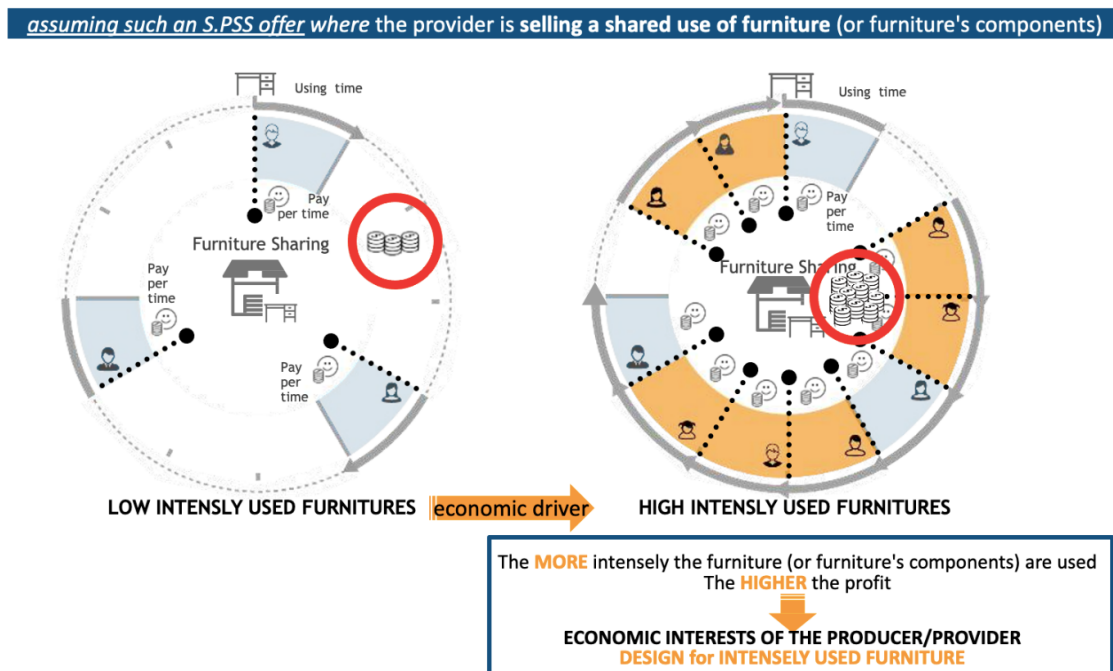


Figure 6. the win-win benefits of S.PSS for furniture (furniture use intensification)

5.3.3 S.PSS for furniture facilitates material life extension (recycling, energy recovery)

As far as the S.PSS for furniture provider is selling all-inclusive furniture with its end-of-life treatment, the more the materials are either recycled or incinerated with energy recovery (environmental benefits), the more costs are avoided of landfilling, the purchasing of new primary materials or energy (economic benefits), see figure 7. Hence, the furniture producer/provider is driven by economic interests to design for material life extension (recycling, energy recovery etc.), by applying furniture LCD strategies, including adopting the cascade approach for furniture; selecting materials with the most efficient recycling technologies; facilitating collection and transportation of disposed furniture; identifying furniture materials; minimising the number of non-compatible furniture materials and/or facilitating their separation.

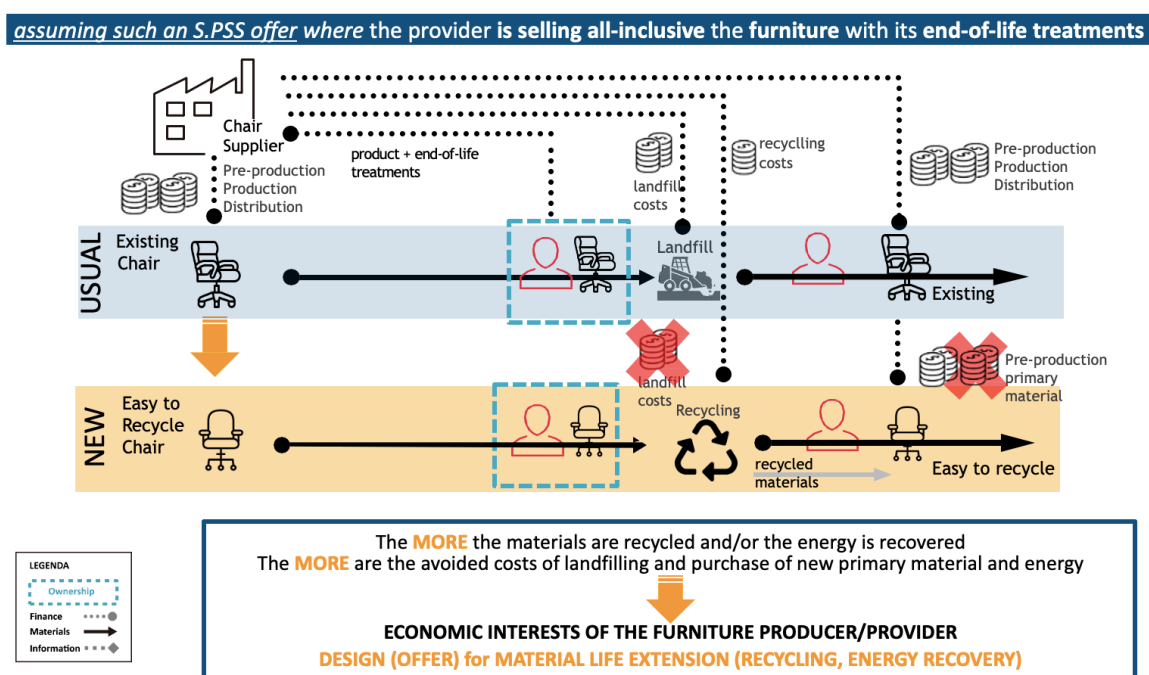


Figure 7. the win-win benefits of S.PSS for furniture (material life extension)

5.3.4 S.PSS for furniture facilitates resources consumption minimisation

As far as the S.PSS for furniture provider is selling all-inclusive access to furniture and responsible for the resources (i.e. materials and energies) it consumes during its life cycle stages, the higher the resources efficiency in all furniture life cycle stages (environmental benefits), the higher the profit (economic benefits), see figure 8. Hence, the furniture producer/provider is driven by economic interests to design/offer furniture and/or services that minimise resources consumption by applying furniture LCD strategies, including minimising the material content of furniture, minimising scraps and waste, minimising or avoid packaging, minimising material consumption during use and minimising energy consumption along the furniture life cycle.

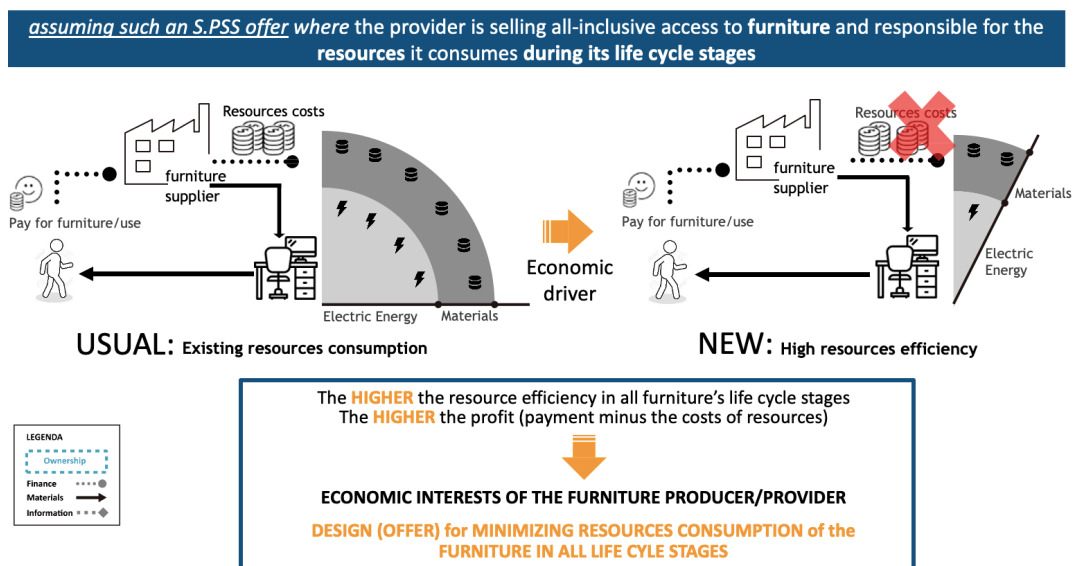


Figure 8. the win-win benefits of S.PSS for furniture (Resources consumption minimisation)

5.3.5 S.PSS for furniture facilitates resources renewability/biocompatibility

When we enlarge the furniture system to include some type of energy/materials consuming furniture in use, such as a workstation, and the S.PSS for furniture provider has an all-inclusive offer of furniture and resources during use, with pay per period/time/satisfaction (e.g. furniture and energy production unit), the higher the proportion of passive/renewable sources (environmental benefits), the higher the profit, i.e. the payment minus (among others) the costs of sources (economic benefits). Hence, the furniture producer/provider is driven by economic interests to design (offer) for resources renewability. See figure 9.

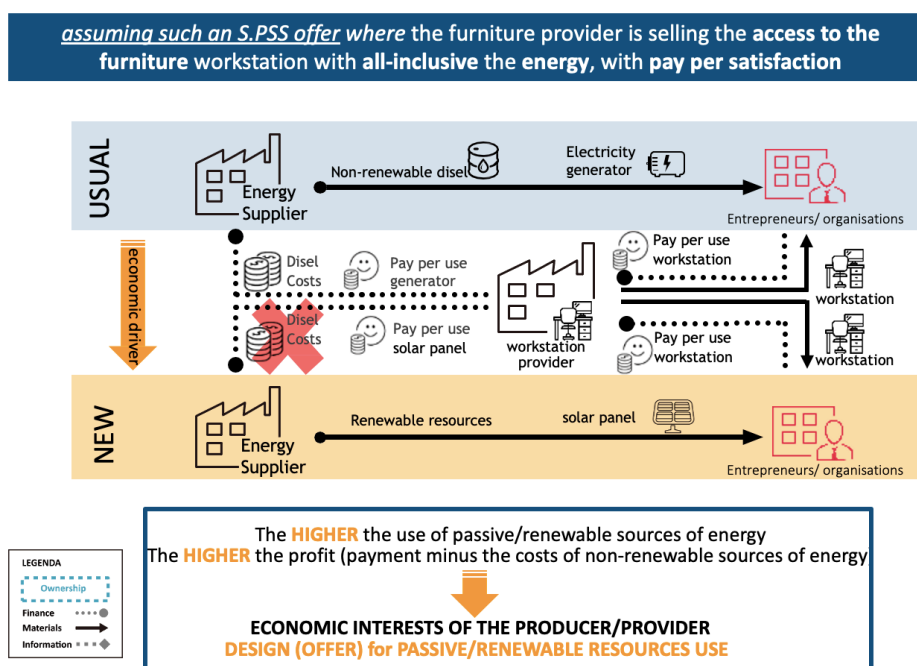


Figure 9. the win-win benefits of S.PSS for furniture (Resources renewability/biocompatibility)

In summary, S.PSS for furniture 1) designs a particular furniture satisfaction unit and all related furniture and services; 2) designs the interactions of the stakeholders (i.e. offer model) of a particular furniture satisfaction system. As a result, within S.PSS for furniture offer, providers continuously seek environmentally new beneficial furniture solutions for economic reasons. In other words, the financial interest of the furniture provider (manufacturer) fosters the design of environmentally sustainable furniture by adopting furniture LCD strategies, see figure 10.

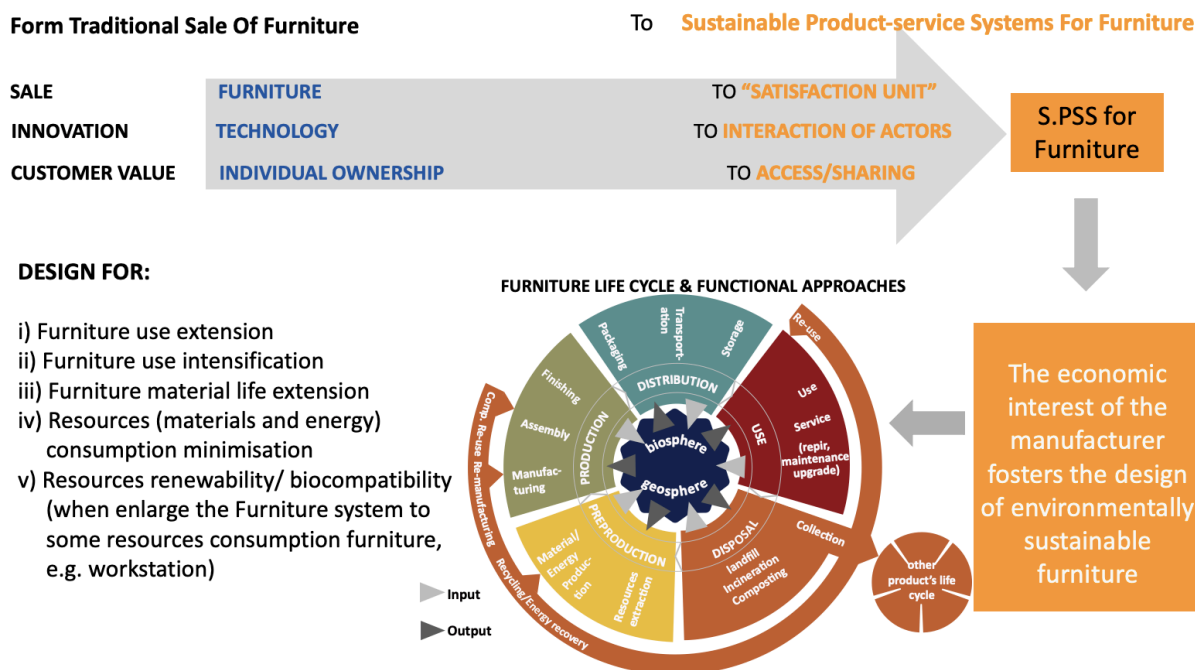


Figure 10. S.PSS for furniture as a model that makes furniture LCD economically relevant for the manufacturer/provider (adapted from Vezzoli et al., 2021)

6. Discussion

Although all researched cases have some win-win benefits among the formerly mentioned aspects, not all furniture cases could be fully and thoroughly considered as well-conceived S.PSS. Here are some key elements that should be considered: 1) The ownership and payment methods. With S.PSS for furniture offers, the ownership of furniture and/or life cycle responsibility retained by the provider who gets paid per satisfaction unit and thus economically interested in conducting furniture LCD strategies. 2) The role of producer and provider. If the same furniture manufacturer offers services, the provider/producer has the economic interest in offering low environmental impact furniture and the direct opportunity/capability to intervene in the furniture design processes (e.g. furniture leasing in the Gispén case), i.e. adopting some of the LCD strategies.

This analysis focuses mainly on the win-win environmental and economic sustainability benefits. Socio-ethical sustainability is another key benefit from S.PSS for furniture worth further research and

scientific debate. This is even more true under the current Covid-19 pandemic crisis which increases poverty and inequality on a global scale. A shift towards Sustainable Product Service-System where the ownership of the product and/or the life cycle services costs/responsibilities remain with the provider have been studied worldwide as promising locally-based sustainable and resilient models envisions a promising characteristic of a “new normality” , sustainable for all (Vezzoli, 2021).

S.PSS for furniture could be a promising approach to deal with social equity problems. The research assumes that, with (care-oriented and result-oriented) S.PSS for furniture, providers offer access to furniture and all-inclusive services, rather than only the furniture ownership to final users, being paid per use of furniture and life cycle services. This offer would avoid furniture purchasing costs, which is frequently too high for low and middle-income users. Thus, furniture would become accessible to even low and middle-income users. Second, This offer would avoid cost for furniture maintenance, repair, upgrade, reconfiguration and end-of-life treatment, which is frequently very high for low and middle-income users. As a result, users could avoid interruption of furniture use.

7. Conclusion: envisioning a pivotal role for the designer

The design may play a crucial role in envisioning a new generation of sustainable furniture systems within the former framework. This case study analysis mainly verifies and characterises five main win-win environmental and economic benefits of S.PSS into the furniture systems. The S.PSS for furniture offer models need to be designed by adopting S.PSS design approaches and tools.

- Adopting a “satisfaction-system” approach to design a particular “furniture satisfaction unit” and its related furniture and services.
- Adopting a “stakeholder configuration” approach to design the interactions of the stakeholders of a particular furniture satisfaction system.
- Adopting a “system sustainability” approach to design such stakeholder interactions (offer model) that providers continuously seek after both environmentally and socio-ethically new beneficial furniture solutions for economic reasons.

Finally, a set of available S.PSS tools could be used for furniture system design, and some tools need research work for specification to be used in the furniture sector. For example, the Sustainable Design Orienting toolkit⁵ (SDO toolkit) for which a set of furniture system-specific guidelines and checklist should be redefined.

According to what is stated by the European Commission (2020), furniture is a critical impacting sector, and up to 80% of products’ environmental impacts are determined at the design stage. Designers can and must play a crucial role, which could be done by adopting “product-as-a-service or other models

⁵ The SDO toolkit contains a series tools to support general S.PSS design, which could be find in <http://lens-europe.eu/tools/view/3>.

where producers keep the ownership of the product or the responsibility for its performance throughout its life cycle.”

Finally, to help achieve a fruitful understanding of the opportunities, it is relevant to develop a sustainable furniture design orienting scenario as an essential part of the reference framework for promising future sustainable furniture S.PSS. The scenario has four visions that could represent future furniture system design possibilities (in the form of polarity diagram, storyboards and videos). Each vision represents a Sustainable win-win configuration, combining socio-cultural, organisational and technological factors, fostering solutions with a low environmental impact, high socio-ethical quality and a high economic value.

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