

European Network of the Heads of Environment  
Protection Agencies (EPA Network) - Interest Group on  
Green and Circular Economy

# CIRCULAR BUSINESS MODELS: PRODUCT-SERVICE SYSTEMS ON THE WAY TO A CIRCULAR ECONOMY

February 2021

**Authors:**

Riina Antikainen, Rachel Baudry, Andreas Gössnitzer, Tiina Kaisa Maria Karppinen, Maikel Kishna,  
Francesca Montevercchi, Felix Müller, Claire Pinet and Rebecca Ugglá

With contributions from Christopher Blum and Christina Pykonen.

**This paper is supported by the following agencies:**

Agence de la transition écologique ADEME

Environment Agency Austria

Federal Office for the Environment FOEN

Finnish Environment Institute SYKE

German Environment Agency

IHOBE, Sociedad Pública de Gestión Ambiental

Italian Institute for Environmental Protection and Research – ISPRA

PBL Netherlands Environmental Assessment Agency

Swedish Environmental Protection Agency

## CIRCULAR BUSINESS MODELS: PRODUCT-SERVICE SYSTEMS ON THE WAY TO A CIRCULAR ECONOMY

### Preface and Acknowledgement:

This document is a discussion paper elaborated and compiled within the EPA Network interest group Green and Circular Economy. Our intention is to share respective country information based on practical case studies, to analyse cross-country experiences and lessons obtained to increase the understanding of the potentials connected to Product-Service Systems (PSS) business models as a cornerstone of the European Green Deal. The paper is intended for the European Commission, the European Parliament and other authorities and organisations at EU and national levels. It is also dedicated as an inspiration to companies and associations that are on the brink of developing and adopting PSS business models.

### Date:

February 2021

### Authors (alphabetical order):

<b>Name</b>	<b>Agency, Country</b>
Riina Antikainen	Finnish Environment Institute SYKE, Finland
Rachel Baudry	Agence de la transition écologique ADEME, France
Andreas Gössnitzer	Federal Office for the Environment FOEN, Switzerland
Tiina Kaisa Maria Karppinen	Finnish Environment Institute SYKE, Finland
Maikel Kishna	PBL Netherlands Environmental Assessment Agency, The Netherlands
Francesca Montevercchi	Environment Agency Austria, Austria
Felix Müller	German Environment Agency UBA, Germany
Claire Pinet	Agence de la transition écologique ADEME, France
Rebecca Uggla	Swedish Environmental Protection Agency, Sweden

**Corresponding author:** Felix Müller

**In the memory of Riina Antikainen**



This position paper is the result of the work of the EPA Network's Interest Group on Green and Circular Economy. While it reflects the inputs of all participants of the Interest Group, it is only endorsed in this form [including policy recommendations] by those Agencies mentioned on the front page.

## Executive Summary

Product-Service Systems (PSS) are a specific type of Circular Business Model (CBM). PSS aim at providing customers with access to a function or service that a certain product delivers or provides, instead of selling the product. The expectations are high for PSS in enabling the transition towards a circular economy as these business models could provide environmental as well as economic gains. PSS offer an opportunity for an almost entirely circular business in line with the sustainable development goals. However, the challenge of change management against linear business habits remains, despite the expected positive impacts. In this discussion paper, eight PSS business cases from different European countries were studied. These represent eight product archetypes which are pivotal in consumption and production patterns:

- Furniture
- Cars
- Chemicals
- Machines
- Tools
- Carpets
- Household appliances
- Textiles in the fashion industry

For each case, practical barriers and benefits of the PSS were identified. The cases provide valuable insights in the changing markets in a circular economy and success factors that should be encouraged. The findings from the cases are summarised and used to draw conclusions that could inform decision making around implementing European circular economy measures.

The studied PSS show that the inherent principle of use without ownership can go along with a fundamental rethinking of how to produce and consume, while maintaining or even increasing the utility value and lowering the environmental impacts. The studied cases illustrate that PSS can, in specific situations, intrinsically stimulate resource efficiency, continuous innovation, and enhanced technological performance. They give an incentive to intensify the collaboration within the entire value chain in order to establish sustainable materials management practices. However, the environmental, economic, and social benefits of the PSS are not self-evident, and the whole production and consumption chain needs to be carefully designed. The potential impacts need to be evaluated before deciding on a certain business model in order to avoid negative trade-offs during the life cycle. Due to path dependencies, it is difficult to change a business model once established.

PSS can be transformative, if producers and suppliers shift from selling goods to providing services, and in that way decrease their own and their consumers' environmental and climate footprint. At the same time all business partners can increase their economic gain and decouple their business goals from the production of goods.

PSS are on the rise in many Business-to-Business (B2B) markets and in Business-to-Consumer (B2C) markets. Both remain challenging and go along with specific barriers that require targeted actions. Most innovative PSS are still small scale and they have not yet been able to fully stimulate the potential organisational innovation in a way that could lead to an economic and environmental win-win situation. The challenge of change management against linear business habits remains, despite

the proven positive impacts. Financial rules and regulations can seriously hinder the development of competitive service business cases.

Confidentiality requirements are a priority for strong circular B2B collaborations. Communication and trust-building between the partners is crucial as shown for chemical leasing. In B2C markets, consumers value convenience and affordability. In many cases, customers still prefer ownership and new goods and materials over old ones.

Synergies between B2C and B2B models may be achieved when service times are prolonged through combined usage by commercial or municipal and private customers at different times a day or week (e.g. for car sharing or gardening machines).

Great opportunities offered through digitalisation can speed up the development of innovative PSS. With the rise of digital technology in industries (e.g. Industrial Internet of things-IIOT), new opportunities emerge. With digitalisation, collaborative efficiencies between suppliers of PSS and users can be intensified, thus multiplying potential benefits. It can as well, through anonymisation (big data) increase customer intimacy of the supplier. Digitalisation however, poses new challenges regarding the ownership and openness of data. Also, the climate impacts of digitalisation, such as energy consumption in data centres, ought to be evaluated.

#### **Policy instruments and measures to stimulate PSS**

This report highlights multiple barriers that are specific or highly relevant to PSS. These barriers can be addressed by specific policy instruments.

A general barrier for PSS (and even sustainable innovations in general) is that the environmental impacts are not reflected adequately in the price of materials and products. If these impacts were internalised, virgin materials and new products would become more expensive. **Pricing** could therefore be a possible lever which can be influenced by **economic instruments** to stimulate the transition towards a circular economy. In that sense, **adjusted taxation** rates could also make PSS more competitive. Labour is more heavily taxed than material resources in the EU. By shifting this, labour-intensive activities, such as maintenance and repair, could be stimulated. These labour-intensive activities are an essential part of PSS. To enable better pricing, a bonus system, such as **tax deductions** for certain economic activities, would be a possibility. A tax deduction for the labour cost when repairing, refurbishing, and reusing goods could be applied. PSS could additionally be supported through green recovery measures (that are a result of the COVID-19 crisis), as they have the potential to enable the transition towards a circular economy.

Policy could also help in **revising accounting standards**. Quickly depreciating assets to zero, and standard calculations for solvency (i.e. an indicator for the financial health of a business that scores lower when more assets are on the balance sheet) make it difficult for PSS to establish a competitive business case. Financial reporting rules should be reviewed with these barriers in mind.

As set out, CBM are a very broad and diverse group, and so are PSS as a major fraction of the promising CBM. All kinds of policy interventions, investments, and regulations to foster the uptake of CBM and particularly PSS will require a **dedicated taxonomy** of these businesses. The taxonomy should include the relevant criteria, characteristics, and differentiating factors. It could be the basis not only for the allocation of funds and resources but also the basis for a decision tree to apply further **environmental impact assessment tools**. Even though PSS are largely environmentally favourable over their linear counterparts, there is a risk of unintended, shifted environmental

impacts and further consequences, such as rebound effects, in case of widespread adoption, which should be avoided.

Investment decisions and efforts to develop PSS face change resilience. The frontrunners on the markets, thereof many small and medium-sized enterprises (SMEs), gain a wealth of experiences and may benefit from first mover advantages. In order to scale up PSS successfully on the markets, it will be important to **share knowledge, experiences, and lessons learnt** through stakeholder dialogues and company forums. Platforms, such as the [European Circular Economy Stakeholder Platform](#), the Enterprise Europe Network, the European Cluster Collaboration Platform, or the previous Resource Efficiency Knowledge Centre, should expand their areas of expertise. They can **provide for branch- and business-specific advice** as well as support for circular business innovations. More importantly, national and regional agencies and centres should be empowered to provide cooperative advice for PSS. Additionally, SMEs trying to implement a PSS experience a lack of support from the financial system. Instruments aimed at **reducing financial risks** are essential to ensure that SMEs are able to enter PSS markets and compete with large enterprises.

It is at the core of PSS that service providers take greater and extended responsibility of their products. The business logic must change from marketing large quantities into providing reliable services based on the optimised, intensified, and prolonged use of products. As such, PSS are an ideal approach for producers and service providers for enhancing the sustainability performance and management of their products along the lifecycle. **An ambitious extended producer responsibility** at the core of a reinforced sustainable products policy framework, as outlined in the Circular Economy Action Plan 2020, has the potential to boost PSS in Europe decisively.

The purchasing power of public authorities represents 14 % percent of EU GDP. **Green Public Procurement** can be a trend-setting instrument in the transition to a circular economy. It can have tremendous positive impacts on the sustainability status of products on the EU Single Market. Practical guidelines could support the contracting authorities in considering service-oriented circular procurement options, such as PSS, instead of traditional purchase-ownership models. In particular, **life-cycle costing** over several financial years and the attribution of environmental externalities in the most economically advantageous tender are levers to favour PSS.

The environmental benefits of PSS are not necessarily easy to communicate to consumers, and the decision-making processes of consumers are not fully understood. Shifting from buying products to using PSS often requires changes in behaviour. It also requires changes in values, such as perception of used products, appreciation of the value and burdens of newly produced goods as well as a willingness to give up personal ownership. **Behavioural research** could be utilised to find leverage points in order to support the broader adoption of sustainable PSS.

## Table of contents

Executive Summary .....	3
1. Introduction.....	7
2. Circular Business Models (CBM).....	9
a. Circularity Strategies in a Circular Economy.....	9
b. Types of Circular Business Models (CBM) .....	10
c. Product-Service Systems (PSS) Business Models in Focus .....	11
d. Digitalisation in a Circular Economy.....	13
e. Digitalisation as an Enabler of PSS Business Models.....	14
3. Country Case Studies.....	16
a. Furniture as a Service: Retailer IKEA (Sweden) .....	18
b. Car Sharing: Insights into the Car Sharing Market (Germany) .....	20
c. Chemical Leasing – Industrial Surface Cleaning: SAFECHEM Europe GmbH (Germany).....	23
d. Gardening Machines as a Service: Manufacturer Husqvarna (Sweden).....	27
e. Renting of Tools: Retailer Clas Ohlson (Sweden) .....	30
f. Buildings -Reusable Carpet Tiles: Interface (Netherlands).....	32
g. Household Appliances: Bundles (Netherlands).....	34
h. Rethinking Fashion: Vaatepuu (Finland) .....	36
4. Lessons Learned .....	39
a. Customers.....	39
Motivations and benefits .....	39
Challenges and Barriers.....	39
b. Businesses .....	39
Motivations and benefits .....	40
Challenges and Barriers.....	40
c. Communities .....	41
Motivations and benefits .....	41
Challenges and Barriers.....	41
d. Synopsis of Benefits, Motivations and Drivers.....	42
e. Synopsis of Challenges and Barriers.....	42
5. Conclusions.....	44
6. References.....	46

# 1. Introduction

Circular Business Models (CBM), such as Product-Service Systems (PSS), can help shift consumer patterns and behaviour towards less resource use and smaller environmental impacts. The fundamental role of those business models is acknowledged in the core strategic documents of European and international policy.

The *European Green Deal* [1] makes the claim to rethink production and consumption patterns in the EU while increasing the sustainable use of resources and improving human health. Under the umbrella of the *European Green Deal* the European Commission published a new *Circular Economy Action Plan – For a cleaner and more competitive Europe* [2]. It envisages a sustainable products policy framework that makes sustainable products, services and business models the norm. The plan will set minimum requirements to prevent environmentally harmful products from entering the EU market. Extended producer responsibility will be strengthened regarding the whole life-cycle of products as well as PSS, where producers keep the ownership of the product.

The previous EU Commission Staff Working Document *Sustainable Products in a Circular Economy – Towards an EU Product Policy Framework contributing to the Circular Economy* [3] specifically addresses collaborative business models. The document concludes that there is a high economic potential as well as a potential for sustainability in the collaborative business models. In the document, eight product categories are prioritised: packaging, food, electrical and electronic equipment (EEE) and batteries, transport and mobility, furniture, textiles, buildings and construction products as well as chemical products. CBM are discussed especially in the context of transport and mobility, textiles and chemical products. It is also mentioned that new business models are being spurred through the digitalisation of the economy. This discussion paper has aimed to illustrate cases related to these prioritised product categories.

The EU Commission Communication *A Clean Planet for all. A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy* [4], highlights the circular economy and new business models. The communication assesses the impact of a highly circular economy and the potentially beneficial role of the change in consumer choices towards carbon neutrality in eight scenarios. It mentions that expansion of new systems and processes, with cooperation across sectors, is required. A good example of such system-oriented approaches is the circular economy, which will harness a range of advanced solutions and foster new business models. The communication concludes that a net-zero greenhouse gas emissions economy will see new business concepts develop with re-use and additional services at its core.

A variety of CBM types exist in the literature [5]. In general, CBM can help achieving longer product and materials life and less resource use by shifting the traditional consumption paradigm of product ownership towards product use and share [5].

This paper focusses on PSS business models as a major category of CBM. In PSS business models, producers remain bound to the product. Producers may be responsible for the product maintenance, repair or recycling and they may offer the product as a service in different forms, such as leasing, renting or shared use. In this way, PSS business models may stimulate a change in consumer patterns and behaviours as well as spur the transition of consumers becoming users and increase the responsibility of producers on their products.

**The discussion paper elaborates on the motivations, benefits, barriers and challenges for PSS business models based on real-life case studies from various sectors and countries. In Chapter 2, the role of CBM for a circular economy is highlighted, PSS business models are characterised, and the synergistic role of digitalisation is underlined. Chapter 3 introduces eight practical case studies and presents their findings in detail. Overall lessons learned are derived in Chapter 4, followed by a synopsis. Reflections on adequate policy measures are to be found in the concluding Chapter 5.**

## 2. Circular Business Models (CBM)

### a. Circularity Strategies in a Circular Economy

A circular economy is focused on the optimal use and reuse of resources in the various links along production chains: from the extraction of raw materials all the way to the consumption and disposal phase [6]. Optimal use and reuse take environmental, economic, and social costs and benefits into account. A circular economy is not a goal, but rather means to address several underlying issues. It could reduce the environmental pressures related to the extraction, processing, use and disposal of resources, reduce short-term and long-term risks of supply as well as drive economic development [7].

There are different strategies available to reduce resource and material consumption. From an environmental perspective, several strategies for resource use can be ranked. In general, the priority is: prevent, re-use, recycle. This line of reasoning is closely related to different waste hierarchies, where the priority is to limit the generation of waste, and only after that to recycle and recover the waste generated [8]. In recent years refinements have been made to this general ranking. In literature many different “circularity ladders” exist, each containing between three and ten different circularity strategies [9] [10] [11].

Figure 1 shows an overview of circularity strategies based on literature. This ladder illustrates the range of potential strategies that can be used in a circular economy. As a rule of thumb, circularity strategies higher up the ladder require fewer primary materials. The use of natural resources, such as land, water and ecosystem services, is also lower for strategies higher up the ladder. In addition, the further adverse environmental effects of primary material production are supposed to be diminished. However, it is not safe to assume that environmental pressure will drop steadily when systems dematerialise. Thus, a sound environmental assessment, concerning the whole product life cycle as well as both the beneficial and detrimental effects, remains necessary [12].

A life cycle assessment on clothing libraries has, for example, shown the importance of substantially increasing the service life of a garment, and considering the logistics in order to achieve environmental gains [13]. The results quantitatively demonstrate the potential risk of problem shifting, where increased customer transportation could offset the benefits gained from reduced production. This highlights the need to take the logistics into account, when implementing collaborative consumption business models. Zamani et al. (2017) also mention the relevance of considering consumer behaviour when assessing the environmental impact [13]. It is crucial to estimate for example how many times a garment has been used before being returned and thereby transported back to the store again.

The “last mile” from store to home by car has also been highlighted in a report on resource efficient transportation and mobility in Sweden, as it is often considered as the most expensive, least effective and the most pollutive one in e-commerce. The communities can take a greater responsibility for logistics, for example by planning terminals for e-commerce, and make sure that the infrastructure is used resource efficiently [14].

Due to the path dependency, a business model is difficult to change once established. Companies that invested extensively in the development of new commercial products and technologies, have little incentive to innovate new business models through which these inputs pass. Empirical evidence indicates that especially established companies focus on lower circularity strategies, such as

recycling, and make changes at the margin instead of shifting their core strategy and business models. In contrast, circular start-ups tend to follow higher levels of circularity strategies than those of incumbent companies, which indicates that circular start-ups can have a significant role in transitioning towards a circular economy [15].

FIGURE 1 TYPOLOGY OF CIRCULARITY STRATEGIES [16]

Strategies		
Smarter creation and use of products	R0 Refuse	Turning a product redundant by cancelling its function, or by substituting it with a radically different product.
	R1 Rethink	Intensifying product use (e.g. via product sharing or multifunctional products).
	R2 Reduce	More efficient use and/or manufacture of products through the use of fewer natural resources and materials.
Extending the lifespan of products and parts	R3 Reuse	Reuse of discarded yet still usable product, for the same purpose, by a different user.
	R4 Repair	Repair and maintenance of broken or malfunctioning product, to enable continuation of its original function.
	R5 Refurbish	Refurbishing and/or modernising an older product, so that the improved version can be used in the product's original function.
	R6 Remanufacture	Using parts of a discarded product in a new product of the same function.
	R7 Repurpose	Using discarded products or their parts in new products with a different function.
Usefull application of materials	R8 Recycle	Processing of materials to achieve the original high-quality or reduce to low-quality.
	R9 Recover	Incineration of materials, recovering their energy.

pbl.nl

## b. Types of Circular Business Models (CBM)

Implementing a viable business model is vital to any business. A business model can be defined as *“the manner by which the business enterprise delivers **value** to customers, entices customers to pay for value, and converts those payments to profit: it thus reflects management’s hypothesis about what customers want, how they want it, and **how an enterprise can organise to best meet those needs, get paid for doing so, and make a profit**”* [17].

Recently, the literature on business models has started to investigate CBM. The concept is not common across Europe and lacks a broadly accepted definition. It is often used synonymously with terms *eco-design, recycling* and *resource efficiency*. The OECD [8, p. 20] argues that the defining aspect of CBM is *“their relative sparing use of natural resource inputs. This results not only from facility level improvements in material productivity, but also from more fundamental changes in production and consumption patterns”*.

CBM cover a broad range of activities. For instance, companies can focus their business model on creating and selling circular resource inputs, i.e. fully renewable and/or biodegradable resources and materials. Online sharing platforms like Peerby and platforms for selling second-hand goods like

eBay, can reduce demand for first-hand products. Business models can also focus on selling waste, such as farms that expand their business model to incorporate the sale of residual resource streams. Several typologies of CBM exist [15] [18] [19] [20]. The OECD [8] follows the approach used by Accenture and defines five CBM-types:

1. **Circular supply:** replacing traditional inputs with bio-based, renewable or recovered materials
2. **Product life extension:** extend product life by ensuring that circularity of material and components is considered at the design phase to allow for direct reuse, maintenance, repair, refurbishment and remanufacturing, recyclability, use of secondary resources for the production
3. **Sharing:** promote the use of underutilised consumer assets more intensively. Prominent examples often cited in the literature are Airbnb and Uber, where private owners can share their assets (as houses and cars) with strangers in exchange for a payment.
4. **Resource recovery:** producing secondary raw materials from waste streams. This business model concerns recycling and recovery of resources from waste to close material loops.
5. **Product-service systems (PSS):** combining a physical product with a service component while ownership remains with the supplier. PSS provide customers an access to a product's function, instead of selling the product.

These CBM are not necessarily new or innovative, as is seen in recycling paper, selling second-hand furniture or renting out tuxedos. However, the specific implementation of CBM might be innovative or even disruptive; and different types of companies have different contributions [15].

## c. Product-Service Systems (PSS) Business Models in Focus

The CBM mentioned above are all relevant in the transition towards a circular economy. PSS are especially relevant as an innovation topic for several reasons.

There are high expectations for the role of PSS in enabling the transition towards a circular economy. Both in policy and in practice arguments are made that PSS have superior environmental performance compared to traditional business models, and that PSS lead to economic gains. For instance, the Ellen MacArthur Foundation [9, p. 22] states: *“circular economy advocates the need for a ‘functional service’ model in which manufacturers or retailers increasingly retain the ownership of their products and, where possible, act as service providers ... Today [PSS] are signs of good resource husbandry and smart management”*.

The expected environmental performance is related to the PSS potentially incorporating multiple circularity strategies. PSS can provide incentives for circularity in the design, production, use and disposal phases. By offering products as a service, manufacturers are incentivised to think about the optimal number of products to supply and to design the products for a longer life. Additionally, the service provider is incentivised to maintain the products and organise a take-back system. In turn, these incentives can lead to significant environmental benefits.

Furthermore, PSS could lead to economic gains. PSS use revenue models that can strongly differ from traditional one-off sales. By offering a product as a service, revenue streams change from one-off to recurring, customer relationships are improved as well as become more long-term, and additional services (regarding maintenance or efficient use) can lead to additional revenues [21].

However, PSS do not provide environmental or economic benefits by definition [21] [22]. For example, detrimental environmental effects may take place if PSS increase consumption instead of replacing current consumption. It is crucial to gain insight into the specific implementation of the business model and determine in which way environmental and economic benefits can be obtained [23].

There are different types of PSS. Tukker [22] distinguishes between product-oriented services, user-oriented services, and result-oriented services.

1. **Product-oriented services** are still mainly geared towards selling products, but with additional services (such as insurance), or authorised product maintenance and update. In this case, the product is owned by the consumer, but the producer can still provide additional services to increase the lifespan of a product.
2. In **user-oriented services** product ownership remains with the provider (such as with leasing or renting) and the consumer gets access to the function of a product. The consumers dispose of the product for a time limited to its usage (such as with car sharing) and the producer is responsible for the maintenance and disposal of the product.
3. In **result-oriented services** the client and provider agree on a result without pre-determining the product involved (such as paying per airplane landing in tire management).

The economic and environmental value increases as a system approaches result-oriented PSS. The result-oriented PSS are the most promising in terms of facilitating a shift towards a circular economy and in establishing sustainable production and consumption patterns [5].

Given the high expectations regarding environmental and economic benefits and the current uncertainties, further research is necessary to establish the role of PSS in the transition towards a circular economy.

A final reason for focusing on PSS is the current scale and potential scalability of this type of CBM. While certain PSS have grown rapidly in recent years, the market penetration of PSS often remains very low. PSS need to move beyond niches to achieve a genuine transition to a more circular economy. To illustrate: urban car sharing schemes have grown from 11.500 vehicles in 2006 to 104.000 vehicles in 2014. However, the shared fleet accounts for less than 0.1 percent of the global in-use car fleet [8]. There are specific challenges that hinder the success of PSS. For instance, firms switching to a service model need to make a large investment, as it requires different skills, resources and partners [22]. Furthermore, literature shows that PSS business models can be quite successful in business-to-business (B2B) markets [22], but struggle in consumer markets that are trend sensitive [22]. Given the potential for win-win situations, where PSS lead to environmental and economic benefits, it seems worthwhile to identify barriers and opportunities for these CBM.

Trendsetters in servitisation (such as Xerox, Rolls-Royce, Michelin, GE as per its Healthcare Division, Siemens via its 'building efficiency as a service' programme or ABB in the form of its collaborative operations centres) are not seldomly cash-rich companies or firms that have a dedicated financial 'arm' in their organigram (think of: GE Capital, Siemens Financial Services or ABB Finance). This allows them to develop payment modalities and financial services offering high user-friendliness; modalities and services that enable them to compete on financial grounds and take competitors aback that cannot compete on these grounds. As such, these actors change the rules of the game and make them more financial. Consequently, being competitive comes to depend increasingly on the ability to offer customer-friendly payment modalities, which in turn requires financial aptitude (from an administrative-procedural perspective and in terms of access to

resources). And these are trumps that tend to be encountered more easily among large corporations with financial muscle power and with experience as regards financing ‘technologies’.

In fact, results from a survey by Kamp (2020) held among approximately 60 small and medium-sized industrial companies from the Basque Country showed that the implementation of servitised earnings models is problematic for most of them. To explain their inactivity in this regard, the consulted companies pointed manifestly at ‘internal accounting practices not fostering outcome-based service contracts’ and ‘a lack of readiness of the financial system surrounding them to support such payment arrangements’ as important barriers. [24]

## d. Digitalisation in a Circular Economy

The idea of the circular economy is to preserve the value and utility of products and components within the economy for as long as possible. This requires integrated approaches which, inter alia, increase and prolong the use of products, consider the reusability and repairability of products in the design phase, and ensure that materials can be substantially recovered after use. Many of these integrated approaches rely on the availability of information about the material composition of each individual product, its patterns of use, its availability and its location. Until recent times it has not been possible to overcome much of this information deficit, mostly due to the lack of appropriate technologies.

Digital technologies can overcome these challenges and drive the transformation towards a more sustainable circular economy. On the one hand, digital technologies will allow answering in a very accurate manner and in real time the following questions: (1) where is a certain resource (material) available, and (2) what is the condition of it regarding its composition, path of usage and integrity? Moreover, digital technologies and integrated systems allow constant monitoring, controlling, analysing and optimisation of products and processes. By addressing these issues, digital technologies can substantially contribute to close material loops while creating lucrative business cases and innovative business models, in a win-win situation. The economic opportunity of Internet of Things (IoT) alone is estimated to reach 10 Trillion of USD in the next decade [25].

The flip side of digitalisation is a potential trade-off with improved material efficiency and increasing energy consumption followed by negative climate impacts, as data centres are a significant energy consumer globally. In addition, building up the infrastructure needed for the digitalisation requires significant amount of materials, especially rare metals and minerals.

The role that digital technologies will play to address the circular economy can be described as follows.

Firstly, the digitalisation will enable real-time positioning of products and materials, which can be used to retrieve information on product availability. This makes it easier to improve product accessibility and enhance collection, refurbishment, recycling, and reuse of waste materials. Numerous digital and collaborative platforms and marketplaces already enable consumers to get real-time information about the availability and location of primary and secondary raw materials, products and even services. The online Austrian platform *Willhaben* offers a marketplace for (among others) second-hand products, and currently, 7.5 million products are posted online for sale by private users [26].

Secondly, digital technologies enable improved knowledge on product and materials condition. The lack of information on the actual usage path as well as condition of materials and products has been

a major factor hampering the functioning of markets for secondary raw material as well as the recycling and reuse market. The increasing use of smart technologies, such as artificial intelligence, smart sensors, and blockchain technology, will offer new ways of improving traceability and transparency throughout the life of the product. Smart packaging, for instance, is a technology in the course of development that will provide quick and efficient ways to monitor the environmental conditions of the food in the supply chain. Based on a technology which combines nanomaterials and smart sensors such as the MFS- Membrane Film Sensors, the smart packaging will be able to check on effective food freshness, reducing unnecessary food spillages while improving food safety [27].

Thirdly, digitalisation enables predictive product maintenance. Mainly based on the combination of the IoT and big data analysis, predictive product maintenance is made possible thanks to connected smart sensors which are increasingly embedded into machines, appliances, and products. They can communicate and send information about the functioning of components, their failures or need for maintenance. Knowledge of the product's condition enables predictive and condition-based maintenance as well as advanced diagnostics and forecasting of components and products. Hence, predictive maintenance increases the reliability and availability of the products. It also extends the life of the products and enables further processing with the historical knowledge of the product. Such systems are already implemented, e.g. for washing machines and other business appliances, and the market is increasingly growing, with predictions on about 25–50 billion connected devices by 2020 [28].

## e. Digitalisation as an Enabler of PSS Business Models

The combination of different digital technologies will allow the creation of innovative, circular business models. Through IoT, companies can predict product conditions, status, location, and usage. The information collected through digital technologies helps companies to provide technical support and other services, such as repair and management of spare parts. The analysis of collected data allows companies to tailor services and products according to the need of consumers. It also allows further savings in resources and energy. Real-time information on product availability to many consumers allows product sharing between multiple users and fosters the so-called collaboration economy. For example, the online collaboration platform FLOW2 [29] allows its users to share appliances which are usually used for very short time periods, such as bore machines, drills, and carpenter tools.

Hence, it can be argued that the potential for innovative CBM will be unlocked by digital technologies, although there are still many open questions related to e.g. the ownership and openness of data [30].

Both scientific and grey literature acknowledge IoT, Big Data, and Data Analytics as well as their combination as enablers for the development of PSS business models [31]. In fact, these technologies are radically reshaping the way companies deliver existing services. The IoT technology allows companies to collect a large amount of data and to customise a servitised product. Through IoT, companies may obtain real-time remote monitoring of product usage, status, and location. Therefore, companies have a great opportunity to gain knowledge on the way customers are using products. Companies may achieve a closer proximity with their customers, thus transforming the interactions between a manufacturer and customers from negotiation to communication.

When products become smart, companies may upgrade only their digital components, such as the product firmware, thus enhancing product upgradability. To find the proper application, analytics need to work with large amounts of data. In this case, analytics allow companies to transform data into insights, which provides the basis for better decision making. Finally, Big Data and analytics are required in the provision of advanced services, such as preventive and predictive maintenance.

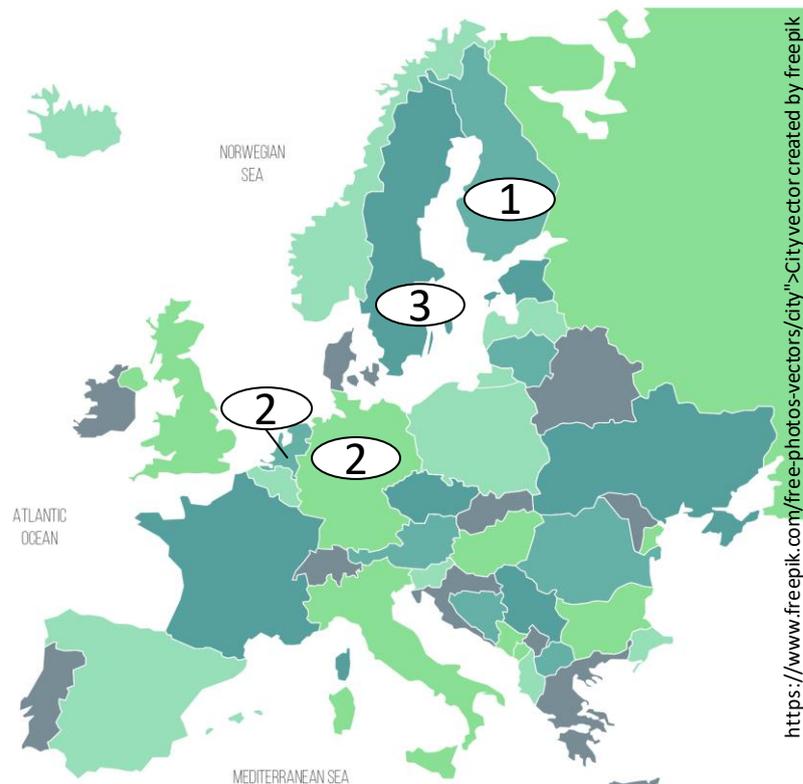
### 3. Country Case Studies

A multi-stage screening process led to the selection of eight case studies for PSS business models. The business models are all based on various circularity strategies with a great priority for rethinking linear habits. The cases represent eight different product archetypes which are pivotal in consumption and production patterns:

- Furniture
- Cars
- Chemicals
- Machines
- Tools
- Carpets
- Household Appliances
- Fashion

The geographical spread is shown in Figure 2.

**FIGURE 2** NUMBER OF CASE STUDIES PER COUNTRY



All cases are elaborated, assessed and described along the same lucid template with the following subheadings:

- Case description (a short introduction to the case study and its rationale)
- What type of business, what type of customers – B2B, B2C
- R-strategy classification (according to circularity strategy ladder in Figure 1)

- Environmental benefit (direct or indirect effects)
- Incremental or transformative potential (degree of innovation and reshaping existing business models)
- Adoption and diffusion (in the country and across Europe)
- Barriers (perceived by the operators, customers or other stakeholders)
- Case-specific insights (optional in some cases)
- Existing incentives (facilitating conditions to establish the PSS)
- Opportunities and market potential (scalability, transferability and overall market share potential)
- Additional information / references

## a. Furniture as a Service: Retailer IKEA (Sweden)

### Case description

IKEA has explored circularity in several markets over the past three years. The company will test furniture leasing in 30 markets during 2020.

Customer behaviour and lifestyles are changing fast, driven by shifts in demographics, a desire for affordability, convenience, digitalisation as well as increasing awareness and concern for social and environmental issues. In order to better meet the needs of IKEA's customers, the company has started a transformation. Becoming truly affordable, accessible, and sustainable requires remodelling of IKEA's business in different areas. To some extent, it also means challenging the status quo.

Transforming into a circular business enables IKEA to tackle these challenges as well as to meet customer needs and dreams in new ways. Testing furniture-as-a-service systems is in line with the company's overall goal of becoming a fully circular and climate-positive business by 2030. Furniture-as-a-service maximises the use of furniture through refurbishment, several lives, component re-use, and material recycling. For this, the company needs to expand the business model it has today.

IKEA's research shows that most of its customers feel bad about throwing items away. It has also been recognised that often there are no solutions for discarding items in a sustainable way. This can lead to excess clutter at home or feelings of guilt. People are in general positive to giving away, selling and fixing, but it must be convenient and relevant. So far IKEA has tested initiatives focusing on taking back, repairing, and giving products a second life through reselling.

The PSS business model of IKEA is a service experience to access furniture without full ownership. It covers the entire customer journey from interest and planning, to getting the goods home and assembled, living with the products including support with maintenance, repairs or upgrade, and finally the end of life support with passing on the products.

IKEA wants to understand if offering a subscription service with renting and leasing components built in can make it possible for the company to deliver a more affordable, convenient, and sustainable solution. That is not only a financing model, but rather a circular model. IKEA aims to maintain ownership of the material or product in order to secure reuse as many times as possible as well as take care of the end-of-life phase through refurbishment, remanufacturing, and recycling of both materials and components. IKEA is co-creating solutions with consumers to better understand expectations on the offer, range and services included, touchpoints and pricing.

### What type of business, what type of customers – B2B, B2C

Initial tests will focus on business-to-business opportunities for a service subscription model with small enterprises.

### R-strategy

Rethink and Reuse.

### Environmental benefit (direct and/or indirect)

Leasing of furniture is in its early stages in IKEA, and thus, the exact impacts of the new business model are not yet known. However, the company expects that leasing of furniture will deliver different business cases. IKEA dares to try this new model believing that it will unlock great potential

for sustainable growth. At the same time, it is working on measuring the climate impact and integrating this into measuring the progress of IKEA's ambition to be climate positive by 2030.

### **Incremental or transformative potential**

This business model can have transformative potential, if companies can shift from selling products to selling services in a way that is decreasing their and their customers' environmental and climate footprint. This is significant especially for global companies, such as IKEA, that have a large up-scaling potential.

### **Adoption and diffusion (in country and across Europe)**

Belgium, Croatia, The Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Ireland, The Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, and United Kingdom.

### **Barriers**

Not known yet.

### **Case-specific insights**

Currently, there are lessons learnt regarding consumer insights. These differ between countries and regions. Depending on the insights, the service model can be offered in different ways and to different target groups for maximum effect of the initial pilot initiatives. For example, the service model can be offered in conjunction with the renting of apartments or rooms, can be directed as a service subscription model towards small enterprises in other markets, or as rental packages for students in yet other markets.

### **Existing incentives**

Customers are increasingly demanding affordability, accessibility, and sustainability. Transforming into a circular business enables IKEA to tackle these challenges and meet customer needs and dreams in new ways. Testing furniture-as-a-service supports the overall IKEA goal to become a fully circular and climate-positive business by 2030.

### **Opportunities and market potential**

Potential of penetration in all IKEA's markets at term.

### **Additional information / references**

Lisa Henriksson, Business designer, Ingka Group (formerly IKEA Group, a strategic partner in the IKEA franchise system with IKEA retail in 30 markets)

## b. Car Sharing: Insights into the Car Sharing Market (Germany)

### Case Description

Car sharing evolved as a concept of a mobility service in a collaborative economy. The key to sharing is a higher degree of utilisation of cars by replacing permanent individual ownership by temporary on-demand access. Car sharing business models may be categorised into two different groups:

1. Car sharing operators that provide users with access to a dedicated fleet of vehicles that are owned or leased by the operator. This group can be further divided into the free-floating model which allows cars to be dropped off anywhere in a designated area and the station-based approach where the vehicle must be returned to the same or at least another station of the operator.
2. Peer-to-peer car sharing, when privately-owned vehicles are made temporarily available for shared use with the intermediary help of an internet platform.

The case considers the evolution of the whole German car sharing market based on statistics of the umbrella organisation of German car sharing operators (bcs). The bcs aims to position car sharing as a modern mobility service in cooperation with local public transport. It represents the political interests of German car sharing providers on a regional and national level. Currently, 139 car sharing providers are members of the bcs.

### What type of business, what type of customers – B2B, B2C

Car sharing is primarily available as a B2C solution in Germany. However, studies suggest that a mix of private and business customers would be a great success factor. This enables a complementary use of vehicles which, in turn, makes particularly economical use of the vehicles available and improves the service to private customers at the weekend when business customers do not generally need the vehicles.

### R-strategy

The inherent principle of use without ownership makes car sharing a prime concept to rethink mobility. Moreover, it is linked to the idea of an exploitation of the underutilised asset, a car, in order to maximise its utility value.

### Environmental benefit (direct and/or indirect)

Previous research has shown that particularly station-based car sharing is able to influence car ownership, and consequently the choice of transport services as well as the direct emissions of mobility linked to it. A great potential of environmental relief results from the renunciation of private cars or from the decision against its new acquisition. People who do not own a private car are much more environmentally friendly concerning transportation, even if they are clients of a station-based car sharing provider, compared to people who have a private car at their disposal.

In the German context, it has been assessed that one station-based car sharing car may replace 10 up to 20 private cars and that car sharing users reduced their car ownership by up to 62 percent, depending on local conditions and spatial boundaries. Both rates are typically lower for free-floating cars. Based on generalisable findings, it is the combination of public transport and car sharing which substitutes private cars and thus raises the potential to save space for stationary traffic significantly.

Another aspect concerns technology: on average, car sharing vehicles are newer than most personal vehicles, meaning that improvements in engine technology, in fuel efficiency and in emission levels are deployed on the road in a timely manner. Thus, each kilometre driven in a shared vehicle results in fewer health-damaging pollutants, such as particulate matter, in the urban environment. It also contributes to decreasing amounts of fossil fuel used and CO<sub>2</sub> emissions likewise.

The potential environmental benefits of car sharing can be further increased considerably by using plug-in hybrid and electric vehicles, provided that the operating power is gained from regenerative energy sources. The percentage of electric vehicles is 50 times higher in the car sharing fleet compared to the average in the national fleet of private cars.

### **Incremental or transformative potential**

Car sharing has the potential to reshape mobility and transport by changing people's behaviour fundamentally. Individualised transport demands can be met in a sustainable and socially beneficial way by decreasing the overall demand for cars, lowering emissions by using smaller and cleaner cars, reducing traffic and parking congestion as well as increasing social cohesion amongst sharers.

### **Adoption and diffusion**

Car sharing is growing in Germany. At the beginning of 2019 2.46 million car sharing users were registered, 350,000 more than the year before. With a growing rate of 21.5 percent, the increase in station-based car sharing was above average. In Germany, 20,200 car sharing vehicles were available at the beginning of 2019, which is 2,250 vehicles more than in 2018. Station-based services provide 11,200 vehicles, which is more than half of the total supply. There are 9,000 vehicles on offer by free-floating providers. It is expected that the gap between free-floating and station-based operators will decrease over time. There is a tendency for flexible operational systems and payment schemes even by the same providers.

### **Barriers**

Inadequate political conditions have been identified as a barrier to the expansion of car sharing. This includes contradictory, and sometimes even counterproductive, political signals as well as support programs and subsidies for car ownership that are implemented to the detriment of car sharing growth. Insufficient knowledge or false understanding of the costs of car ownership and the cost structure of other transport modes as well as, above all, the emotional connection to the car and its significance as a status symbol can be counted as personal barriers.

### **Existing incentives**

The dissemination of information on the cost effectiveness of car sharing use has been identified as a success factor. In addition, the user-friendly car sharing technology plays an important role in the reliability of the service. Furthermore, the legal framework has been amended. The new car sharing law in Germany (2017) established a legal basis for public parking spaces, as well as other help for car sharing to be established. Local authorities are now able to create parking spaces that are available for car sharing cars exclusively. It also allows for reductions or exemptions from parking charges for cars registered with a car sharing scheme. In addition, car sharing will benefit from the expansion of low emission zones in inner cities.

### Case-specific insights

The coexistence of different business models and the significantly different fleet size of car sharing operators indicate that each business model is viable, but in different types of urban environments.

Station-based and free-floating business models are not only used differently by customers, they also have different effects on mobility and the environment. On one hand, users of station-based car sharing systems are more likely to belong to car-free households, they also use local public transport more often and reduce the number of journeys made by car to a greater extent. Free-floating car sharing, on the other hand, reaches significantly more users than station-based systems and can therefore compensate for its lower efficiency by increasing its customer reach. This is also the reason why free-floating systems in some cities today can get more private cars off the road than station-based systems. Recent surveys conclude that the greatest efficiency in that respect is achieved by combined business models which allow users to profit from the respective benefits of station-based and free-floating car sharing equally.

### Opportunities and market potential

Car sharing has been growing steadily in the last decade, not only in Germany, but all over Europe. The European research and innovation action STARS foresees an increasing number of users, with different expected growth rates depending on the local administrations actions. These forecasts are mainly justified in terms of the rising population in cities, the popularity gained by car sharing services, the rising costs of owning a private car, and the increasing awareness of citizens about environmental issues. Besides electric vehicles and Internet-of-Things applications, the introduction of self-driving cars represent opportunities for car sharing and adapted business models.

### Additional information / references

- bcs (June 2016). Bundesverband Car sharing e.V. Car sharing statistic 2019: Car sharing in Germany is still on a growing path. Retrieved from <https://carsharing.de/presse/pressemitteilungen/car-sharing-statistic-2019-car-sharing-germany-is-still-on-a-growing-path>
- Loose, W. (2009). The State of European Car-Sharing. Brussels: Intelligent Energy Europe (momo project). Retrieved from [https://ec.europa.eu/energy/intelligent/projects/sites/ieeprojects/files/projects/documents/momo\\_car\\_sharing\\_the\\_state\\_of\\_european\\_car\\_sharing\\_en.pdf](https://ec.europa.eu/energy/intelligent/projects/sites/ieeprojects/files/projects/documents/momo_car_sharing_the_state_of_european_car_sharing_en.pdf)
- Münzel, K., W. Boon, K. Frenken and T. Vaskelainen (2018). "Car sharing business models in Germany: characteristics, success and future prospects." *Information Systems and e-Business Management* **16**(2): 271-291
- STARS (2018). Shared mobility opportunities And challenges for European cities. Deliverable 2.1 - Car sharing in Europe: a multidimensional classification and inventory. Retrieved from <http://stars-h2020.eu/>
- STARS (2018). Shared mobility opportunities And challenges for European cities. Deliverable 2.3 - The growth of car sharing in a business as usual scenario. Retrieved from <http://stars-h2020.eu/>
- STARS (2018). Shared mobility opportunities And challenges for European cities. Deliverable 4.1 - The influence of socioeconomic factors in the diffusion of car sharing. Retrieved from <http://stars-h2020.eu/>
- UBA (2015) German Environment Agency. Environmental Benefits of Innovative and Integrated Urban Mobility Concepts (Summary). Retrieved from

[https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2016-12-14\\_umkomoko\\_end1\\_kurz-eng\\_fin.pdf](https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2016-12-14_umkomoko_end1_kurz-eng_fin.pdf)

## c. Chemical Leasing – Industrial Surface Cleaning: SAFECEM Europe GmbH (Germany)

### **Chemical Leasing - An archetype of PSS**

Traditionally, chemicals are sold to customers who use them to fulfil certain functions. Chemicals suppliers have an economic interest in increasing the amount of chemicals sold. In a common business practice a focus is placed on higher sales volumes (*“the more you sell, the more you earn”*). However, in many cases this is associated with negative impacts on the environment and negative consequences for the future availability of resources.

### **UNIDO definition of “Chemical Leasing” [32]**

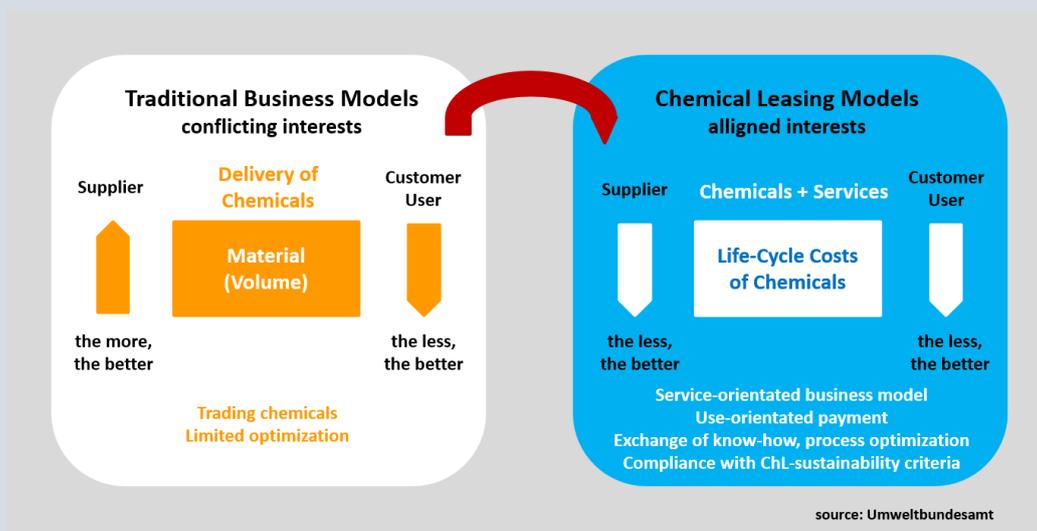
*Chemical Leasing is a service-oriented business model that shifts the focus from increasing sales volume of chemicals towards a value-added approach. The producer mainly sells the functions performed by the chemical and functional units are the main basis for payment.<sup>1</sup> Within Chemical Leasing business models the responsibility of the producer and service provider is extended and may include management of the entire life cycle. Chemical Leasing strives for a win-win situation. It aims at increasing the efficient use of chemicals while reducing the risks of chemicals and protecting human health. It improves the economic and environmental performance of participating companies and enhances their access to new markets. Key elements of successful Chemical Leasing business models are proper benefit sharing, high quality standards and mutual trust between participating companies.*

Chemical Leasing inverts a supplier's commercial interest in a higher consumption of chemicals (

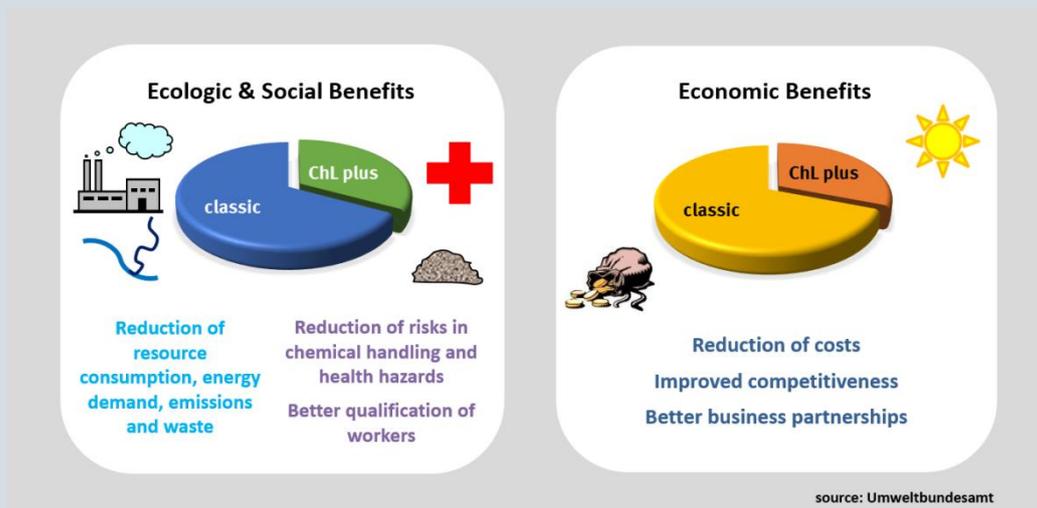
---

<sup>1</sup> functions performed by a chemical might include: numbers of pieces cleaned; amount of area coated etc.

Figure 3). Under Chemical Leasing, the supplier sells the functions performed by the chemical, and functional units (number of pieces cleaned, amount of area coated, etc.) become the main basis for payment.

**FIGURE 3 THE CHEMICAL LEASING APPROACH**


Chemical leasing is a one-of-a-kind sustainable business model, leading to more efficient and economic use of chemicals. It also contributes to lower water, raw material, and energy consumption, significantly reducing the environmental impact of the production process. It helps reducing occupational health and safety risks as well as protecting human health from the hazardous effects of chemicals. By sharing, the added value created through the more economic use of chemicals, both the chemical supplier and user can gain an economic advantage. It can also foster long-term collaboration between the partners, leading to innovation and the transfer of environmentally sound technology (Figure 4)

**FIGURE 4 THE ECOLOGIC, SOCIAL AND ECONOMIC BENEFITS OF CHEMICAL LEASING**


In line with the concept of sustainable development, it is necessary to ensure that all Chemical Leasing activities follow the principles of sustainability.

### Case description

SAFECEM is a service company responsible for the sustainable and innovative use of chemicals. It provides sustainable solutions for high-precision metal surface cleaning, dry cleaning and asphalt testing applications based on chlorinated and non-chlorinated solvents. COMPLEASE™, the Chemical

Leasing model of SAFECHEM for the surface cleaning industry, is a holistic closed-loop delivery system for handling solvents which comprises:

- high performance solvents
- a dedicated system for a safe take-back of used solvent (SAFE-TAINER™)
- waste management services
- technology and know-how to monitor the solvent quality
- stabilisation technology for a maximum solvent life-time
- in depth and applied industry know-how such as training, analysis and consultancy
- digital services (CHEMAWARE™ knowledge services) for increased level of safety for the workers and the environment.

For the unit of payment, a time-based set-up was established. The annual consumption of solvent, waste take-back and service products as well as consultancy and training, is calculated based on the customer's specific production data and is charged at fixed monthly rates. This set-up enables a very stable and transparent cost situation for all parties and can be used by end-users to clearly calculate the cleaning costs per part, basket or lot.

### **What type of business, what type of customers – B2B, B2C**

The business model is offered as a business-to-business service and rental concept. SAFECHEM is working with industries such as the aerospace, aeronautic, electronics, and automotive industry, where highest precision cleaning quality is mandatory.

### **R-strategy**

The COMPLETE™ Chemical Leasing model is a servitisation business model including recycling service as a standard, but inherently triggering intensified reuse, and striving for better risk management. Based on close collaboration with customers, it stimulates resource efficiency, continuous innovation, and enhanced performance. It gives an incentive to intensify the collaboration with the entire value chain to reduce the solvent consumption.

### **Environmental benefit (direct and/or indirect)**

The solvent's life span in a closed cleaning machine can be extended significantly by applying the COMPLETE™ Chemical Leasing model optimizing the on-site reuse loop (on-site distillation) of the solvent. All aspects of the life cycle – from design and selection of solvents to usage phase and to recovery – have been carefully considered to enhance resource efficiency. It was calculated that the full solution provided with COMPLETE™ Chemical Leasing can reduce up to 80 percent primary solvent consumption and up to 80 percent solvent content in the waste stream.

The reduced consumption of solvent usage at customer sites leads to reduced solvent production, which is strongly linked with indirect energy savings through material flows. Additionally, but to a lesser extent, there are direct energy savings as the result of process optimisation.

### **Incremental or transformative potential**

The potential can be transformative, if producers and suppliers will shift from selling chemicals to selling services in a way that is decreasing their and consequently their customers' environmental and climate footprint. At the same time all business partners can increase their economic gain and decouple their business goals from the production of chemicals.

### **Adoption and diffusion**

Currently, SAFECHEM offers the COMPLEASE™ Chemical Leasing model across Europe, for both metal cleaning and asphalt testing industry. Geographic expansion, for example in China, is also currently evaluated.

### **Barriers**

The confidentiality requirements are a priority for the participants in this case. The improvements in the process represent a competitive advantage for all partners, and this should not be endangered by communications with third parties. Therefore, communication and trust building between the partners is crucial.

The acceptance of the COMPLEASE™ Chemical Leasing model as a new way of doing business still faces change resilience. The challenge of "change management" remains, despite the proven positive impacts and the support from public organisations.

In the meantime, SAFECHEM faces operational challenges. For example, there are no clear accounting rules defining how a performance-oriented business model, based on a monthly flat rate and including product delivery, should be accounted for.

Finally, some legislative barriers remain. Despite the European common market, the transportation of waste still requires cross-border notifications, which increases complexity and costs of implementing the Circular Economy.

### **Case-specific insights**

The Chemical Leasing business model offered by SAFECHEM enables customers to achieve the required quality by using the optimum solvent technology within an optimised cleaning process and therefore keeps them competitive in global markets. It is a long-term business model that creates a win-win-situation for all parties involved and that may improve their public image.

Contracts in this area have relatively detailed provisions covering cooperation. The following parameters are of key importance: the supplier has increased responsibility for the optimisation of the production line; a joint team enables a better optimisation; the production line is mainly the responsibility of the user; process parameters are monitored and documented; the personnel of the user are trained by the supplier; the willingness of the chemicals' supplier to provide short-term solutions for special occurrences on the production line is crucial.

### **Existing incentives**

The Chemical Leasing concept is economically feasible, also in the context of highly developed countries. The environmental performance is improved, e.g. consumption of fresh chemicals, energy use, emissions, waste production, and operating risks are reduced.

In addition to its inherent benefits for the involved parties, the business model has received public recognition. Several best practice recognitions were awarded to SAFECHEM by UNIDO in 2010, 2012, 2014 for demonstrating the potential benefits. In 2016, SAFECHEM received the prestigious CEFIC responsible care award across categories for its application: The SAFECHEM Chemical Leasing Model: Unlocking the potential of Circular Economy.

In 2017, SAFECHEM was awarded Runner Up of The Circularity, the world's premier circular economy award program, an initiative of the World Economic Forum and the Forum of Young Global Leaders.

### Opportunities and market potential

For an industry as large as the chemical industry and in a society facing the increasing pressure of climate change, an innovative business model such as chemical leasing represents an excellent opportunity. The switch from a volume-oriented approach to a performance-oriented model is not possible across all sectors of the industry. However, the short- and long-term benefits can be so drastic that it could contribute to a great extent to the transformation towards a more circular economy.

With the rise of the digital technology in the industry (e.g. Industrial Internet of Things (IIOT=), new opportunities emerge. With digitalisation, the efficiency of the collaboration between the supplier and the user of the chemical can be intensified, thus multiplying the potential benefits. It can as well, through anonymisation and Big Data, increase the customer intimacy of the supplier. This can help the company to further improve their offering towards higher eco-efficiency.

### Additional information / references

Camille Vicier, Sustainability Manager, SAFECHEM Europe GmbH

## d. Gardening Machines as a Service: Manufacturer Husqvarna (Sweden)

### Case description

Husqvarna is shifting from a manufacturer of gardening machines and tools to also becoming a service provider. Historically, the products have never been sold directly to end consumer but rather via retailers. For Husqvarna, it is important not to address all circular economy as sustainable practice. There needs to be a life-cycle analysis approach to reassure the environmental benefit.

One specific PSS business model is the battery box “Tools for You” of Husqvarna that was launched two years ago. It will be available in Sweden, Germany, France, and US and later this year also in Australia. The renting concept enables the customer to rent for an example a trimmer, chainsaw or hedge trimmer per unit time the customer wants to use it.

A reason for Husqvarna to launch the battery box was to test the market demands as well as the customers wish to access expensive machines and tools more affordably. Servitisation is the smart thing to do, but it also is the right thing to do according to Husqvarna. The new business model presents the company’s ambition to conduct business by using resources in a more efficient way.

In the battery box power tools are included. The tools are rented per day and collected at the box. When returned, they are quality-checked.

### What type of business, what type of customers – B2B, B2C

The PSS business model could be offered as a *business-to-business* leasing concept, as well as a *business-to-consumers* rental concept. It would be interesting to find the business model collaborations, e.g. when a municipality is using the products during weekdays and private consumers during evenings and week-ends. That could increase the usage of the product considerably. The concept could be tested in a small scale to be able to learn from that before up-scaling.

**R-strategy**

Rethink and Reuse.

**Environmental benefit (direct and/or indirect)**

A master thesis assessing environmental impacts of a tool rental service from Husqvarna using life cycle assessment includes a holistic environmental perspective (covering transports etc.). Husqvarna is reporting its carbon footprint scope 3.

The analysis for the rental system shows that user transport back-and-forth to the rental service is a key contributor to all the environmental impacts analysed, if done by private cars. The comparative results to sales business model indicate that while the rental service can help to reduce the potential impacts in mineral resource scarcity and toxicities due to the lower number of products needed, the user transport may outweigh the potential improvements in global warming potential and fossil resource scarcity, depending on the distances and modes of transport.

**Incremental or transformative potential**

The potential can be transformative, if companies can shift from selling products to selling services in a way that is decreasing their and consequently their customers' environmental and climate footprint.

**Adoption and diffusion (in a country and across Europe)**

It is currently available in Sweden, Germany, France, and US and later this year also in Australia.

**Barriers**

Barriers for the PSS business model are technical problems, accessibility of the product, payment difficulties or that the attitudes of the customers. Customers do not always react in a rational way, when testing new PSS business models.

Digitalisation needs to be fully developed before PSS business models can be fully successful. This is crucial for sharing concepts beyond the neighbourhood, when a global aspect is present, as for digital systems' ability to track objects.

The price is a barrier. If the service is too expensive, the customers might instead buy a less expensive product.

The collection and return at the store can be a barrier as it depends on the distance of travel for the customer.

The way of payment can also be a barrier, and it needs to be simple for the customer to pay with established payment methods.

Another barrier is the difficulty to achieve permanent customer satisfaction, e.g. through a quality check of the product to make sure that it is ready to be used.

**Case-specific insights**

To reach the environmental potential of the service it is recommended to optimally place the service close to the users and to take efforts to reduce user transports around the service. The sensitivity analyses in the master thesis also indicate the importance for accounting detailed data for LCAs for PSS and covering the service holistically in system boundaries. Further studies on user behaviour

have also suggested to carry out more robust analyses on consumer services to cover also potential rebound effects.

To enable better pricing in PSS business models, a bonus-malus system, such as tax deduction or subsidies, would be a possibility. A good example on this is the tax deduction for the labour cost when repairing white goods (Sweden, introduced 1 January 2017). Different variations of discounts to customers would be beneficial for the adoption of the new business model.

It is also important with EU compliance and regulations that the company can offer the same product in several markets.

### **Existing incentives**

The marketing potential has been very positive. In general, there is an interest and demand of these types of services from the public. It is therefore important that a business can provide services that fit the customers and their needs instead of meeting only company's own needs

### **Opportunities and market potential**

Potential of penetration of PSS business models in all Husqvarna's markets at term. The company will explore and test more service models.

The concept is not only to deliver a product as a service, but also to deliver value. This has resulted in several different service offers, such as smart gardening for a municipality, making the maintenance of parks more efficient. This in turn decreases the environmental impacts. The municipality saves costs, but also gets additional value in more resource efficient managing of their parks and city gardens.

Another example is an app for better knowledge of plants and flowers, biotopes and growing conditions. The app can be used to create higher biodiversity in the parks and city gardens.

This is a way of transforming from a product provider to a sustainable parks and garden provider, with completely other motives at hand.

Husqvarna sees that there is a range of other values that can be created for the cities with the help of the company's knowledge. The objective is to increase the value of the parks and to convey the additional value, such as the ecosystem services it provides regarding draughts, heat waves, air pollution, and heavy rains, as well as recreational values regarding that people become healthier visiting parks.

In this way, the service is not only about a product as a service, but also creating and conveying the economic, environmental and health value to society.

With the help of digitalisation, a lot of interesting opportunities are created.

### **Additional information / references**

Jonas Willaredt, Environment & Sustainability, Husqvarna AB

## e. Renting of Tools: Retailer Clas Ohlson (Sweden)

### Case description

Clas Ohlson has since a couple of years back engaged in a pilot project of renting tools, and since 2018 broadened it to several stores. The reason for Clas Ohlson to start this PSS business model was that the company wanted to solve the customer's needs in a more sustainable and climate efficient way. Products are a large part of the company's core business and Clas Ohlson wants to tackle the use of resources and climate gas emissions related to products in order to reduce the company's environmental and climate footprint.

The current products that are part of the renting concept are electrical power tools such as drills, screwdrivers, and lock saws. These are products that are not used often, but only occasionally. The tools can be rented per day, and accessories (consumables) are payed separately. The tools rented are the same type as in the sales assortment. Power tools are a good product category to start a PSS with, since they require low maintenance. If maintenance needs arise, they can be easily serviced by the workshops of Clas Ohlson. The company also currently has repair services in their workshops. The tools rented are of higher standard, which is attractive to customers.

For the moment, tools can only be rented in physical stores, and not online.

In the future, the company considers broadening the renting concept to include other product categories, such as larger cleaning machines. Also, the business model will be expanded to be part of a digital platform and a sharing concept, customers in between. The service offer will also be developed to provide customers with additional services, such as installations, take-backs of used lamps or batteries, and sustainability advising for energy efficiency.

### What type of business, what type of customers – B2B, B2C

The PSS business model is offered as a business-to-consumers rental concept.

### R-strategy

Rethink and Reuse.

### Environmental benefit (direct and/or indirect)

The objective is to move from products sold to services sold, and in that way reduce the amount of resources used as well as increase the usage of the products, so that their efficiency will be increased. This way the number of products produced can be decreased, contributing to a decrease in the company's environmental and climate footprint.

### Incremental or transformative potential

The potential can be transformative, if retailers can shift from selling products to selling services in a way that is decreasing their and consequently their customers' environmental and climate footprint.

### Adoption and diffusion (in country and across Europe)

Currently the CBM is offered in Sweden, Norway and Finland.

### Barriers

The investment cost is quite high to pay for enough stock of tools to be rented. Therefore, the rental cost cannot be kept too low while the pricing needs to be attractive for the customer.

For an established firm to transfer to new business models, from product to PSS business model, the digital system in the company can be a barrier. Digital systems need to be developed as well, and it is not always an easy and straight-forward task. The digital systems and logistics were developed to fit products, not services. The challenge also includes transferring from physical stores to renting via the web, in order to be able to scale up properly. The digital infrastructure and logistics requested for this transfer is a substantial task.

Furthermore, an established firm with focus on products, experiences the challenge of the new service business model taking space and time from the original product business model.

It is also a challenge to integrate the different customer channels, i.e. physical stores, e-commerce, and social media.

A big barrier is that products are cheap, and labour is expensive, also including works such as reparations. Especially regarding reparations, it is easier and cheaper to buy a new product instead of repairing the old.

Another barrier is for the renting service to be attractive to customers. Renting involves extra work for the customer, e.g. returning the tool.

#### **Case-specific insights**

Decreasing the price of labour would be helpful in order to achieve more competitive pricing for services. For an example tax deduction on reparation services could be used. This also includes repair services, easily accessible by handing in the product to any of the stores, that would be more attractive if the price would be lower.

There is a contradictory development with consumers. On one hand being conscious and accepting second hand products as well as repairing products, but on the other hand buying directly imported, extremely cheap, yet possibly not sustainable products, online. Better regulation and information concerning the content of hazardous substances, durability, or other properties of different products could be helpful.

The more regulation and EU recommendations we have, the more companies can adhere to objectives of CBM. A good initiative mentioned by Clas Ohlson is the EU Scoring system to rate reparability (GEN - 898.00).

#### **Existing incentives**

Besides the incentive of potential large effects on the company's environmental and climate footprint, there is a lot of positive response from the customers. The customers have been keen on the PSS business model. The services are growing. For the growth to be more exponential, there is a need to attract more customers to the service option and to get the whole society more in line with the new ways of using rather than consuming.

#### **Opportunities and market potential**

There is a plan to broaden and expand the PSS business model to more product groups and additional services as well as wider market penetration.

#### **Additional information / references**

Anna Wastring, Sustainability Program Manager, Clas Ohlson

## f. Buildings -Reusable Carpet Tiles: Interface (Netherlands)

### Case description

Interface manufactures carpet tiles with a life span of 15 to 20 years. Most companies aim to change their interior every 7 years. Therefore, Interface produces carpet tiles that are designed to be reused. Instead of gluing the tiles to the floor, they use adhesive strips (TacTiles) that allow the tiles to be easily removed. Furthermore, the tiles are designed in such a way that they can be combined and placed in any order, which enables the reuse of tiles in different locations.

The company uses a sale and buy-back model. Customers can opt to buy the tiles or to rent them. Interface offers a buy-back guarantee. They also buy-back carpets from other manufactures. The residual value is determined after inspection.

Interface has several services related to the tiles: design, installing, maintenance, cleaning, and refurbishing. Besides daily cleaning, the tiles are intensively cleaned every couple of months. When removing tiles, they are first analysed to determine which one can be reused directly, and which need to be recycled.

There are more examples of PSS in the buildings-category, such as Philips, Mitsubishi Elevator Europe and CEFUR. Philips creates a 'light plan' to ensure the required amount of light is delivered with the optimal number of light bulbs which remain as the property of Philips. The user pays for lux used. Mitsubishi Elevator Europe sells vertical meters or lift movements, instead of selling the ownership of the elevator. The elevator is designed for a longer life span. Coupled with maintenance services, less materials are required during the longer lifespan of the elevator.

### What type of business, what type of customers – B2B, B2C

Business-to-business, such as schools, the hospitality sector, health care, and offices.

### R-strategy

Reduce, Reuse, Repair, Recycle

### Environmental benefits (direct and/or indirect)

Interface calculated that 63 percent of the carbon footprint of carpet tiles is caused during the extraction of raw materials. Enhancing the life span of this product, and thereby reducing the need for new resources and carpets, can therefore lead to a significant reduction of environmental pressures. Tiles that cannot be reused are recycled. A tile made of 100 percent recycled materials has a 35 percent lower carbon footprint compared to a tile made of virgin materials. Recycling is energy-intensive.

### Incremental or transformative potential

The business model is potentially transformative, as it could perhaps also be transferred into a business-to-consumer model. Furthermore, it differs from the traditional business model in the carpet sector, which is traditional sale. However, traditionally there are numerous cleaning and maintenance companies. If manufacturers provide these services, it could lead to structural changes in the sector.

### **Adoption and diffusion (in country and across Europe)**

Since 2006 over 40 million square meters of carpets have been placed using TacTiles. Interface is a globally operating firm.

#### **Barriers**

One barrier is the negative perception of 'second-hand'. Most customers have a strong preference for new products. Customers that have reused their own carpet tiles do seem to become more open to the idea of reuse.

Also, the tax on labour is too high compared to the tax on resources. This makes this type of a business model more difficult and less attractive for investors.

Financial rules are another barrier for the practice. VAT rules treat new and used products and materials the same. At the same time, customers are often not willing to pay the same price for used tiles as for new tiles (Copper8 et al., 2019). By changing VAT rules, the purchasing price of refurbished tiles will be lower and more attractive for the user.

#### **Existing incentives**

Interface's model offers customers a cost-advantage. Reuse is cheaper, customers can earn money from the carpet they supply back to Interface, and even more money if the carpet is in better condition. Thus, the business model supports customers in enhancing their own sustainability.

#### **Opportunities and market potential**

This business model is fully aligned with Interface's long-term ambitions. Interface aims to be fully sustainable in 2020. To achieve this goal, they aim that all the raw materials they use are either 100 percent recycled or bio-based. Several innovations are implemented in their carpet tiles to achieve this. For instance, old windscreens from cars are turned into useful components for the carpet tiles.

The use of carpet tiles brings several advantages to customers. Re-use of carpet tiles is more affordable, particularly when re-using the tiles, they have previously used themselves. If customers take good care of their carpet, they will benefit from a higher buy-back price. An interesting observation by Interface is that customer that re-use their own carpet tiles are generally very pleased with the results, which makes them more open to re-using carpet tiles from others. Customers are satisfied that they can give their office a new and clean look with re-used carpet tiles.

In the future, Interface wants to use a carpet-subscription called Tile Exchange. In this case, customers can choose from a pool of tiles that can be used for 2 to 7 years. If customers want to change the look of their floors, they can hand in the previous tiles and select new ones available in the pool.

## g. Household Appliances: Bundles (Netherlands)

### Case description

Bundles offers subscriptions on washing machines, dryers, and dishwashers to households. In all cases Miele appliances are used, as these machines are long lasting and efficient.

As an organisation Bundles is positioned between the producer (Miele) and the customers. Bundles is the owner of all the machines. Installation, maintenance, and repair are all included in the subscription. Customers also pay a small fee per washing cycle, which provides an incentive to use the machines efficiently. A specially developed app provides customers with insights into their costs, as well as water, energy, and detergent usage. Furthermore, the app provides tips to save on resources and costs.

### What type of business, what type of customers – B2B, B2C

Bundles is mainly aimed at the business-to-consumer market. Miele appliances are relatively expensive. In this service model, customers pay a monthly fee that is considerably lower than the one-off purchase price. This potentially makes these high-end appliances more affordable for consumers that cannot or do not want to spend a larger sum up front.

There are also some instances, where Bundles provides the service to an entire apartment complex. In these cases, shared laundry rooms are created.

### R-strategy

As described above, this business model provides Bundles and customers with incentives to use the machines efficiently, which is an example of the Reduce strategy. Additionally, Bundles is focused on Reuse, Repair, and Refurbish. When machines are returned, they are cleaned and used for another customer or in a shared laundry room. Older machines could be upgraded or are send back to the manufacturer.

### Environmental benefit (direct and/or indirect)

According to Bundles, the average customer will save 2,000 litres of water, 75 kWh of electricity, and up to 30 percent of detergents per year. Bundles also points out that less appliances will become waste to be landfilled, and that Miele appliances last roughly twice as long time as an average washing machine.

Environmental benefits could be improved if Miele became part of this new business model. Currently, Miele still earns most of its revenues on the traditional market and does not have an incentive to take back washing machines, reuse their parts, or design washing machines with increased circularity in mind, for instance by adopting modular designs.

### Incremental or transformative potential

The case has transformative potential, but increasing the impact requires further collaboration with the original producer as explained above.

### Adoption and diffusion (in country and across Europe)

Bundles is currently only available in the Netherlands. It is unclear whether the company is going to expand internationally.

## Barriers

Bundles mentioned three main barriers: (1) the customers mindset, (2) pre-financing, and (3) convincing other actors in the value chain.

Customers are used to buying products. They find it difficult to compare the costs of buying a product to the costs of a subscription. It takes longer to explain the service-concept to customers and customers find it difficult to assess the value of the entire service package. Bundles is also still learning about the best ways to communicate with customers. *“We sometimes ask the customer to use less detergent. Do they appreciate this, or do they find this annoying?”*

It was difficult to secure pre-financing and these difficulties still hinder the growth of the firm. A certain amount of washing machines needs to be purchased initially, but due to the relatively small monthly revenues from subscriptions, the payback time is somewhat longer. Additionally, Bundles points to issues with the way residual value and depreciation is calculated. Accounting rules require investments to be depreciated in a certain amount of time, while the products and materials might still hold (significant) value. Bundles feels that this residual value is not considered strongly enough.

Finally, collaborating with others, such as customers and suppliers, is challenging. It is difficult to contractually establish shared responsibilities, risks, and revenues with different actors in the value chain. Firms are used to collaborate based on a linear model. Because of the novelty of this type of a business model, partners are often hesitant to make major commitments.

## Existing incentives

The total cost of a Bundles subscription is slightly lower compared to the total costs of purchasing a standard washing machine and slightly higher compared to the purchase of a high-end washing machine (according to Bundles' calculations). The benefit for consumers is that maintenance is included in the price. In addition, the Wash-app included in the price provides tips to lower usage costs. The benefit for Bundles is the long-term and frequent contact with their customers. Furthermore, the residual value of the washing machines is higher due to this service model.

## Opportunities and market potential

While Bundles started with subscriptions to washing machines, the number of available subscriptions and appliances types has grown. For instance, there are washing subscriptions that include or exclude detergent. Other subscriptions are available for dryers, dishwashers, coffee machines, and beds.

## h. Rethinking Fashion: Vaatepuu (Finland)

### Case description

Clothing is currently consumed almost as single-use items. Maintaining or repairing clothing is becoming rare. The price of clothes has gone down, but so has the quality. People are struggling to distinguish between high- or low-quality materials. Many of us may stray on impulse purchases in a hurry of everyday life. Yet, people want to dress sharp for work or occasions.

Soile-Maria Linnemäki, the founder of Vaatepuu, has a mission of changing the way we see fashion. - She started her own leasing shop for clothing in a small town of Järvenpää in order decrease the amount of clothes people are buying. The company offers high-quality clothing as a service. In addition, the aim of the service is to educate people on sustainability and textile maintenance.

### What type of business, what type of customers – B2B, B2C

Vaatepuu's business strategy is based on selling half-year memberships for individual clients (B2C) (Figure 5). The price of the membership is determined based on the needs of the customer. The customers with a need for basic clothes can purchase an affordable membership. Other customers with higher expectations for materials or in need of evening wear can purchase a wider service package. Single rentals take place as well, yet the main business revolves around memberships.

**FIGURE 5** VAATEPUU PROVIDES HIGH-QUALITY CLOTHING AS A SERVICE WITH EMPHASIS ON EDUCATION ON THE MAINTENANCE FOR LONG-LASTING GARMENTS. (PHOTO BY SARA SULIN.)



### Environmental benefits

According to a report by Ellen MacArthur Foundation, textile production is responsible for larger greenhouse gas emissions than international air traffic and maritime shipping together. There is a serious need for rethinking the consumption of fashion. Leasing of long-lasting clothing offers an alternative for single-use fashion for those who crave for variety in their appearance.

The clothes on lease in Vaatepuu are exclusively long-lasting and high-quality garments from Nordic brands. Vaatepuu not only provides clothing as a service, but also educates its users on more sustainable practices regarding to fashion. It is compulsory for the customers to maintain the clothing before returning. Clients get detailed instructions on the washing and ironing of each of the garments and different kinds of materials. The clothing is also repaired and maintained in the shop in order to ensure as long lifetime as possible.

In addition to the direct environmental benefit of people buying fewer clothes, there are other kinds of non-direct benefits as well. Membership has helped 58 percent of the customers to better understand the importance of clothes maintenance.

There is a social aspect in the concept as well. Using a “shared wardrobe” increases the sense of community among the people living in cities. According to the experiences in the stores, the users of the service enjoy the sense of community created around the service. The users give each other advice and support. The fitting of the leasing clothes has become a social event.

### **R-strategy**

Vaatepuu’s business model business is based on rethinking the current system. It is no longer required to own at least that many clothes or buy a new dress for every occasion. People can have variety in their style without over-burdening the environment and the chance of impulse purchases is decreased.

### **Incremental or transformative potential**

The business is turning consumer behaviour more sustainable. The business itself is still small, yet there is a vast capacity to grow due to the extensive markets for clothing globally.

### **Adoption and diffusion**

Currently, the company is the only leasing chain for clothing in Finland with four stores in four towns. The company has grown organically based on the need and wishes from the customers. Regular clients wished for change in the selection. The most sustainable way to make that happen was to build up a network of leasing shops with rotating selection of clothes. The business is still small yet growing. In the future, the main aim is to go online, since the one shop in town is becoming hard to reach for many people.

The company is in cooperation with a laundry chain to provide a more flexible return service. Customers are encouraged to use the laundry shop with a discount. As the customers pick up the garments on location, they check the actual item before taking it to home. The company is not willing to expand to post-delivery service as it could lead to unnecessary logistics.

Using the service seems to change consumer behaviour. According to a questionnaire by Vaatepuu, 88 percent of their members have decreased the unnecessary clothing purchases after getting the membership.

### **Barriers**

The business is still small, and the retail shop can be difficult to reach for the busy customers. The concept of leasing everyday clothing is rather new, so even knowledge on the alternative is often lacking.

### **Case-specific insights**

Membership-based business model increases consistency and stability to the operations compared to single rentals with high fluctuation. Membership is also more affordable for the customer. A half-year membership offers a timeline that is long enough for adopting a new way of life.

As there is a wide variety in the value of the different garments, it was crucial to formulate a pricing system that takes the variety into account. A payback time for a silk gown is rather different than

that of a basic t-shirt. Currently, customers can choose between different price levels in the memberships based on their individual needs.

Vaatepuu is cooperating with Nordic fashion brands. On one hand, Vaatepuu gets high-value garments to their leasing service with lower cost increasing the attractiveness of the service. On the other hand, Vaatepuu customers become familiar with local brands and learn to distinguish between high- and low-quality garments.

### **Existing incentives**

Currently, the materials used in each garment must be listed within. There are also labelling systems that aim at conveying the sustainability the piece of clothing. However, determining the overall sustainability, including for instance the conditions of production, environmental burden and durability, is challenging.

### **Opportunities and market potential**

Almost everywhere in the world, people are wearing clothes. Clothing is often considered an important part of culture and identity. Currently, leasing services for clothes are arising both in Europe and North America as well as in Asia. Based on the brake-through of entertainment-as-a-service concepts, such as Spotify or Netflix, clothes leasing has a high potential of changing the way we dress.

### **Additional information / references**

Soile-Maria Linnemäki, CEO, Vaatepuu, interview, March 2019.

Ellen MacArthur Foundation, *A new textiles economy: Redesigning fashion's future*, (2017, <http://www.ellenmacarthurfoundation.org/publications>)

Lucy Hooker, *Will we soon be renting rather than buying our clothes?* (26.9.2018, BBC News <https://www.bbc.com/news/business-45630395>)

**Further information:** <https://vaatepuu.fi/> (only in Finnish)

## 4. Lessons Learned

In the following, an excerpt of main motivations and benefits on the one hand and barriers and challenges on the other is provided out of the eight case study examinations. Different perspectives are taken for customers, businesses, and communities since they have specific demands, requirements, and preferences. Finally, the findings are consolidated in a synopsis.

### a. Customers

#### Motivations and benefits

Customers are demanding affordability, accessibility and sustainability to increasing extent (chemical leasing, furniture, carpet tiles, household appliances).

Sociological studies show that a growing part of consumers (especially young generations) agrees to share products/cars and is not as attached to ownership as before.

Customers wish to access durable, high-quality products (household appliances, gardening machines, fashion).

Customers are in general positive towards giving away, selling for second hand, and fixing. However, it must be convenient and relevant (furniture and tools).

In addition to convenience, people are seeking experientiality and a sense of community in the services (fashion). Experientiality can make the more sustainable choice preferable compared to business-as-usual.

The users of services can clearly calculate and are allowed for a transparent cost situation (chemical leasing).

#### Challenges and Barriers

The acceptance of new offers to fulfil one's needs faces change resilience, especially when the services are not considered convenient by customers (chemical leasing, gardening machines, tools, household appliances, fashion).

Customers tend to have emotional or even glorified connections to certain types of products such as cars. These products have a significance as a status symbol or positional good (car sharing, household appliances).

Services may be less readily available than the conventional alternatives such as retail shops (fashion).

Customers often prefer new goods and have a negative perception of used products and materials (car sharing, carpet tiles, household appliances).

Insufficient knowledge or false understanding of the total costs of ownership along the lifecycle of products inhibits the adoption of services instead of owned products (car sharing, gardening machines, household appliances).

### b. Businesses

## Motivations and benefits

The business models stimulate intrinsically resource efficiency, continuous innovation, and enhanced technological performance (chemical leasing).

PSS direct product design towards higher quality and enhanced reusability and reparability. The companies offering more durable options are show-cased in PSS (fashion, tools, carpet tiles).

The intensified use of goods is triggered and as such its utility value and productivity (car sharing, tools).

Companies are given a strong incentive to intensify the collaboration with the entire value chain. Cooperation amongst service-providers may allow more varied customer service and broaden the spectrum of potential users (household appliances, fashion).

The suppliers of PSS have increased responsibility for the optimisation of the production line in B2B manufacturing markets or the performance of the PSS for user. Whereas the suppliers are provided with process specific information for optimisation, the users are trained by the suppliers for a safe and efficient process performance (chemical leasing).

Both, B2B and B2C models enable a very stable and transparent cost situation for the service providers (chemical leasing).

Offering additional services or long-term contracts instead of one-time payments

increases the stability, allows better orderliness in the business practice and even increases the cash flow (carpet tiles, household appliances cases, chemical leasing, fashion).

The adoption of CBM helps keeping companies competitive in global markets and may improve their public images (chemical leasing, furniture).

## Challenges and Barriers

The investment cost can be quite high for an adequate stock in line with market requirements (fashion, tools, gardening machines, household appliances).

The confidentiality requirements are a priority for strong circular B2B collaborations. The improvements in processes represent a competitive advantage for all partners, and this should not be endangered by communications with third parties. Therefore, communication and trust building between the partners is crucial (chemical leasing).

Operationally, there are no clear accounting rules defining how a performance-oriented business model based on a monthly flat rate and including product delivery should be accounted for (chemical leasing).

Previous studies show that especially small and medium-sized enterprises (SMEs) have difficulties to develop payment modalities and financial services (renting of tools, household appliances) offering high user-friendliness, modalities and services that enable them to compete on financial grounds.

## c. Communities

### Motivations and benefits

Brick-and-mortar service businesses seem to create a community of like-minded people, which enhances the sense of community amongst the customers (fashion).

CBM based on peer-to-peer model help increasing social cohesion amongst sharers (car sharing).

New ways to organise transport with sharing schemes have the potential to significantly save space for stationary traffic. Fuel efficiency and lower emission levels are deployed on the road in a timely manner (car sharing).

Air emissions are reduced. Each kilometre driven in a shared vehicle results in fewer health-damaging pollutants, such as particulate matter, in the urban environment. It also contributes to decreasing use of fossil fuels and CO<sub>2</sub> emissions likewise (car sharing).

Car sharing is a gateway for electric vehicles on the markets. Share of electric vehicles is 50 times higher in the car sharing fleet compared to the average in the national fleet of private cars (car sharing).

### Challenges and Barriers

CBM such as carsharing is not independent from legal and structural boundary conditions, such as the public transport services. It is the combination of an effective and complementary public transport as well as car sharing which substitutes private cars and thus raises the potential to save space for stationary traffic significantly (car sharing).

Contradictory, and sometimes even counterproductive, political signals as well as support programs and subsidies hamper the increase of environmentally benign solutions (car sharing).

The coexistence of different types of CBM is needed according to different types of urban environments, purchase power and consumption behaviour (car sharing).

## d. Synopsis of Benefits, Motivations and Drivers

Taken together, the cases provide several policy-relevant insights. While not guaranteed, the cases illustrate that significant environmental benefits and economic gains are possible. The studied firms see economic opportunities in the shift towards service-models. All cases have a transformative potential. The studied PSS all strongly differ from the traditional business models in their respective markets. If these service-oriented business models can capture a larger market share, the related sectors could transform. These insights are in line with earlier insights on the role of CBMs and specifically PSS in the transition towards a circular economy [8] [21] [22]. Considering the efforts of the EU and several member states making a transition towards more circular economies, supporting PSS seems worthwhile.

A general impression from the cases is that consumers are demanding affordability, accessibility and sustainability to an increasing extent. IKEA, for instance, explicitly states these changing consumer preferences as a motivation for experimenting with their furniture-as-a-service concept. Consumers also wish to gain affordable access to high-end goods, such as high-quality clothing, tools, and appliances. Vaatepuu and Bundles do exactly this. By providing different price-levels in their subscriptions, consumers can afford access to high-quality materials or high-quality brands. The entry-costs are reduced, since consumers pay a relatively small periodic fee as opposed to a significantly higher price in the case of a traditional one-off sale. It is even possible that the PSS leads to lower overall costs for consumers. Interface is one of the firms that can show reduced costs for consumers that decide to reuse carpet tiles.

Offering or using PSS could be a way for businesses to become more circular and operate within the boundaries set by the sustainable development goals (SDGs). The adoption of PSS helps keep companies competitive in global markets and may improve their public images. The cases show several examples, where the service-model intrinsically stimulates resource efficiency, continuous innovation, and enhanced technological performance. SAFECEM's chemical-leasing case illustrates the efficiency gains from delivering a process that is optimised according to each customer's exact specifications. Other cases, for instance those that provide gardening equipment and power tools as a service, show how the PSS can lead to the intensified use of goods, and correspondingly an increase in utility value and productivity.

Finally, PSS business model enables a stable and transparent cost and revenue situation for all parties. Offering additional services or long-term contracts instead of one-time payments increases the stability of cash flows, allows better orderliness in the business practice and could potentially even increase the cash flows.

## e. Synopsis of Challenges and Barriers

Despite the benefits and transformative potential, many of the cases are still operating at a relatively small scale. In many of the cases the service provider is still learning and experimenting with its business model. Service providers try to figure out how to best attract consumers, how to address their needs and preferences, and which propositions and subscription types are best suited to do so. There are many challenges and barriers that hinder the growth and further diffusion of PSS models. There are even several curious challenges that seem to directly contradict some of the benefits and drivers discussed above.

While customers are, in general, positive towards offering and using second-hand goods, and open to the idea of fixing used products, there is a limit to what they are willing to accept. Convenience is an important pre-condition. If a PSS requires too much effort in obtaining or returning the products, the service becomes less attractive. Furthermore, despite the generally positive attitude, most consumers are still used to buying and owning products. Literature shows that most customers even prefer owning products due to the emotional value they attribute to ownership and the status that comes from owning certain products [22]. In many markets the largest customer groups have a negative perception of the quality of used products and materials. The cases regarding car sharing, gardening tools, carpet tiles, and household appliances all show the challenges created by the mindset of consumers.

Another curious contradiction is related to the transparency of the costs of PSS. The leasing and renting models studied here are new in their respective markets. Customers can have difficulties in understanding the total costs of the service compared to the costs related to regular purchases and ownership. They can even have a false understanding of the costs. Bundles argues that it takes longer to explain the service-concept to customers. Furthermore, they have noticed that customers find it difficult to assess the value of the entire service package. Customers are not accustomed to considering all the costs during the lifetime of products.

Finally, there are several financial barriers specific to PSS. Several cases mention the relatively high initial investments that are needed to build-up stock. What amplifies this barrier is the longer payback periods. This leads to higher prices which makes it more difficult to establish a competitive advantage compared to the traditional sales model. Furthermore, several accounting standards and financial regulations compound the investment challenge. The depreciation standards in accountancy may incentivise to regard a product's value as declining rapidly. This promotes the take-make-waste model [33]. Large enterprises have a significant competitive advantage compared to SMEs in the PSS markets due to lower financial risks and improved capabilities to provide user-friendliness and monopolise the markets [24]. SMEs experience a lack of readiness of the financial system surrounding them to support such payment arrangements.

The current VAT system in many countries favours traditional sales of new products over PSS and used products. The case of Interface, for instance, reveals how VAT rules lead to higher prices for used products and materials. This makes it more difficult to compete with new products. Also, when it comes to second-hand products in take-back business models, VAT is paid by every new user of the same product. All these challenges lead to a situation in which it is more difficult to establish a competitive PSS. One final barrier in this category which is also relevant for other CBM besides PSS is the relatively high tax on labour and relative low tax on materials. Eventually, newly manufactured products may be cheaper than labour intensive ones provided by a CBM by refurbishment or repair. This report highlighted multiple barriers that are specific or highly relevant to PSS. These barriers can be addressed by specific policy measures and instruments, when further shaping the European Green Deal as well as its subsequent strategies and action plans.

## 5. Conclusions

A general barrier for PSS and even sustainable innovations is that the environmental impacts are not reflected adequately in the price of materials and products. If these impacts were internalised, virgin materials and new products would become more expensive. **Pricing** could therefore be a possible lever which can be influenced by **economic instruments** to stimulate the transition towards a circular economy. In that sense, **adjusted taxation** rates could also make PSS more competitive. Labour is more heavily taxed than material resources in the EU. By shifting this, labour-intensive activities, such as maintenance and repair, could be stimulated. These labour-intensive activities are an essential part of PSS. To enable better pricing, a bonus system, such as **tax deductions** for certain economic activities, would be a possibility. A tax deduction for the labour cost when repairing, refurbishing, and reusing goods could be applied.

Policy could also help in **revising accounting standards**. Quickly depreciating assets to zero, and standard calculations for solvency (i.e. an indicator for the financial health of a business that scores lower when more assets are on the balance sheet) make it difficult for PSS to establish a competitive business case. Financial reporting rules should be reviewed with these barriers in mind.

As set out, CBM are a very broad and diverse group, and so are PSS as a major fraction of the promising CBM. All kinds of policy interventions, investments, and regulations to foster the uptake of CBM and particularly PSS will require a **dedicated taxonomy** of these businesses. The taxonomy should include the relevant criteria, characteristics, and differentiating factors. It could be the basis not only for the allocation of funds and resources but also the basis for a decision tree to apply further **environmental impact assessment tools**. Even though PSS are largely environmentally favourable over their linear counterparts, there is a risk of unintended, shifted environmental impacts and further consequences, such as rebound effects in case of widespread adoption, which should be avoided.

Investment decisions and efforts to develop PSS face change resilience. The frontrunners on the markets, thereof many SMEs, gain a wealth of experiences and may benefit from first mover advantages. In order to scale up PSS successfully on the markets, it will be important to **share knowledge, experiences, and lessons learnt** through stakeholder dialogues and company forums. Platforms, such as the Enterprise Europe Network, the European Cluster Collaboration Platform, or the previous Resource Efficiency Knowledge Centre, should expand their areas of expertise. They can **provide for branch- and business-specific advice** as well as support for circular business innovations. More importantly, national and regional agencies and centres should be empowered to provide cooperative advice for PSS. Additionally, SMEs trying to implement a PSS experience a lack of support from the financial system. Instruments aimed at **reducing financial risks** are essential to ensure that SMEs are able to enter PSS markets and compete with large enterprises.

It is at the core of PSS that service providers take greater and extended responsibility of their products. The business logic must change from marketing large quantities into rather providing reliable services based on the optimised, intensified, and prolonged use of products. As such, PSS are an ideal approach for producers and service providers for enhancing the sustainability performance and management of their products along the lifecycle. **An ambitious extended producer responsibility** at the core of a reinforced sustainable products policy framework, as outlined in the Circular Economy Action Plan 2020, has the potential to boost PSS in Europe decisively.

The purchasing power of public authorities represents 14 % percent of EU GDP. **Green Public Procurement** can be a trend-setting instrument in the transition to a circular economy. It can have

tremendous positive impacts on the sustainability status of products on the EU Single Market. Practical guidelines could support the contracting authorities in considering service-oriented circular procurement options, such as PSS, instead of traditional purchase-ownership models. In particular, **life-cycle costing** over several financial years and the attribution of environmental externalities in the most economically advantageous tender are levers to favour PSS.

Even if there would be economic incentives and data on the environmental benefits of PSS available, the **consumption habits** of individual people are required to change. The environmental benefits of PSS are not necessarily easy to communicate to consumers, and the decision-making processes of consumers are not fully understood. Taking up PSS often requires changes in behaviour. It also requires changes in values, such as perception of used products, appreciation of the value and burdens of newly produced goods as well as willingness to give up personal ownership. **Behavioural research** could be utilised to find leverage points in order to support the broader adoption of sustainable PSS.

## 6. References

- [1] European Commission, “Communication from the Commission - The European Green Deal,” European Commission, Brussels, 2019.
- [2] European Commission, “A new Circular Economy Action Plan - For a cleaner and more competitive Europe, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions,” European Commission, Brussels, 2020.
- [3] European Commission, “Sustainable Products in a Circular Economy - Towards an EU Product Policy Framework contributing to the Circular Economy, Commission Staff Working Document,” European Commission, Brussels, 2019.
- [4] European Commission, “A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy,” European Commission, Brussels, 2018.
- [5] M. Yang and S. Evans, “Product-service system business model archetypes and sustainability,” *Journal of Cleaner Production*, vol. 220, pp. 1156-1166, 2019.
- [6] T. Rood and A. Hanemaaijer, “Opportunities for a circular economy,” PBL Netherlands Environmental Assessment Agency, The Hague, 2017.
- [7] OECD, “Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences,” OECD Publishing, Paris, 2019.
- [8] OECD, “Business Models for the Circular Economy - Opportunities and Challenges for Policy,” OECD Publishing, Paris, 2019.
- [9] Ellen MacArthur Foundation, “Towards the Circular Economy - Economic and business rationale for an accelerated transition - Vol. 1,” Ellen MacArthur Foundation, 2013.
- [10] J. Potting, M. Hekkert, E. Worrel and A. Hanemaaijer, “Circulaire Economie: Innovatie meten in de keten,” Planbureau voor de Leefomgeving PBL, Den Haag, 2016.
- [11] D. Reike, W. J. V. Vermeulen and S. Witjes, “The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options,” *Resources, Conservation and Recycling*, vol. 135, pp. 246-264, 2018.
- [12] F. Müller, J. Kosmol, H. Keßler, M. Angrick and B. Rechenberg, “Dematerialization — A Disputable Strategy for Resource Conservation Put under Scrutiny,” *Resources*, vol. 68, no. 6, pp. 1-32, 2017.
- [13] B. Zamani, G. Sandin and G. M. Peters, “Life cycle assessment of clothing libraries: can collaborative consumption reduce the environmental impact of fast fashion?,” *Journal of Cleaner Production*, no. 162, pp. 1368-1375, 2017.

- [14] The Royal Swedish Academy of Engineering Sciences, "Resurseffektiva transporter och mobilitet i Sverige – Vad behövs?," 2020.
- [15] M. Henry, T. Bauwens, M. Hekkert and J. Kirchherr, "A typology of circular start-ups: An Analysis of 128 circular business models," *Journal of Cleaner Production*, no. 245, 2020.
- [16] J. Potting, M. Hekkert, E. Worrell and A. Hanemaaijer, "Circular Economy: Measuring innovation in the product chain," PBL Netherlands Assessment Agency, the Hague, 2017.
- [17] D. J. Teece, "Business Models, Business Strategy and Innovation," *Long Range Planning*, vol. 43, no. 1-2, pp. 172-194, 2010.
- [18] E. Achterberg, J. Hinfelaar and N. Bocken, "Master Circular Business with the Value Hill," 2016.
- [19] K. van Renswoude, A. ten Wolde and D. Jan Joustra, "Circular Business Models - Part 1. An introduction to IMSA's circular business model scan," IMSA, Amsterdam, 2015.
- [20] Accenture, "Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth," Accenture Strategy, 2014.
- [21] S. Remmerswaal, A. Hanemaaijer and M. Kishna, "Van betalen voor bezit naar betalen voor gebruik,," PBL Planbureau voor de Leefomgeving, Den Haag, 2017.
- [22] A. Tukker, "Product services for a resource-efficient and circular economy – a review," *Journal of Cleaner Production*, no. 97, pp. 76-91, 2015.
- [23] K. Manninen, S. Koskela, R. Antikainen, N. Bocken, H. Dahlbo and A. Aminoff, "Do circular economy business models capture intended environmental value propositions? Journal of Cleaner Production 171: 413-422.," *Journal of Cleaner Production*, no. 171, pp. 413-422, 2018.
- [24] B. Kamp, "Assessing the financial aptitude of industrial firms to implement servitised earnings models," *International Journal of Business Environment*, vol. 11, no. 1, pp. 1-10, 2020.
- [25] Accenture, "Winning with the Industrial Internet of Things - How to accelerate the journey to productivity and growth," Accenture, 2015.
- [26] Willhaben, 2020. [Online]. Available: <https://www.willhaben.at/iad>.
- [27] M. V. Kiryukhin, H. H. Lau, S. H. Goh, C. Teh, V. Korzh and A. Sadovoy, "A membrane film sensor with encapsulated fluorescent dyes towards express freshness monitoring of packaged food," *Talanta*, no. 182, pp. 187-192, 2018.
- [28] D. Evans, "The Internet of Things - How the Next Evolution of the Internet is Changing Everything," Cisco Internet Business Solutions Group (IBSG), 2011.
- [29] FLOW2, 2020. [Online]. Available: <https://www.flow2.com/>.
- [30] M. Antikainen, T. Uusitalo and P. Kivikytö-Reponen, "Digitalisation as an Enabler of Circular Economy," *Procedia CIRP*, no. 73, pp. 45-49, 2018.

- [31] A. Pagoropoulos, D. C. Pigosso and T. C. McAloone, "The Emergent Role of Digital Technologies in the Circular Economy: A Review," *Procedia CIRP*, no. 64, pp. 19-24, 2017.
- [32] Chemical Leasing Ltd., "chemicalleasing," 2019. [Online]. Available: <https://chemicalleasing.org/>.
- [33] Copper8, S. van Aspert, M. Polet, C. van Oppen, R. Smeets, P. Wit, C. van Dam, J. van Muiswinkel, A. van Scherpenzeel, V. Moll and A. Waltrecht, "Circular Revenue Models: Required Policy Changes for the Transition to a Circular Economy," Copper8, 2019.