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Circular PP

Summary report work package 2.2
Alternative business models available for circular procurement

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“Alternative business models available for circular procurement.”
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This summary report has been made as a result of the INTERREG Baltic Sea Region project Circular Public Procurement. It reflects what has been done in the state of the art workshops under work package 2.2 of the CPP project.

Preface

The following report presents the findings of work package 2.2, of the CircularPP project. The focus of this work package is to analyze and provide an overview of best practices within business model innovation for a circular economy and provide recommendations for business models and partnerships approaches suitable for circular public procurement.

In this study, circular public procurement is considered as "the process by which public authorities purchase works, goods or services that seek to contribute to closed energy whilst and material loops within supply chains, minimising, and in the best case avoiding, negative environmental impacts and waste creation across their whole life-cycle" (European Commission 2017b, 5)

The methodology is based on analysing innovative business models suitable for a circular economy. The scope of the business models analysed is limited to small and medium enterprises, operating the partner countries of the project (i.e. Denmark, Finland, Netherlands, Latvia, Poland, Sweden and Russia) and specialized on the following product groups, which were selected as relevant amongst the partners of the project (i.e. food and food-based products, furniture, built environment, ICT equipment, textiles and miscellaneous).

The report is divided in four sections:

- Section I introduces the topic of Circular Economy in general, and in particular the context of small and medium enterprises is addressed through the concept of Circular Business Models. This serves as the theoretical foundation for the study.
- In Section II is described the methodology followed during the research.
- Section III presents the overview of 50 cases of Circular Business Models, arranged by product group Furthermore, 10 of these 50 cases are analysed in depth and presented separately in the form of "cases".
- Section IV concludes with the overview of CBM for each category group and recommendations related to public procurement and how it can promote and obtained the most benefits out of the out of the identified business models.

Contents

I. Introduction

1) Linear and circular flows in the economy.

Since the 1950s, industrialized economies have followed a model for incentivizing the economy based on accelerating production and consumption of short-life and disposable products (Stahel and Clift 2015). This approach, known as the "linear economy" relies on the constant extraction of materials from nature and an uninterrupted flow of these materials through the economy in the form of products. (Ellen MacArthur Foundation 2015). The linear economy model jeopardizes the stock and recovery rates of both renewable (e.g. forest, fisheries) and non-renewable resources (e.g. minerals, oil). In addition, it generates a constant flow of waste into the environment (including greenhouse gas emissions and other chemicals), which results in environmental degradation and climate change. Overall, the linear economy is part of the reason why the life-sustaining natural systems of the planet are currently at risk (O'Neill et al. 2018).

A Circular Economy (CE) is characterized by resource flows that are narrowed, slowed and closed (Bocken *et al.*, 2016). Flows are narrowed either by decreasing the total extraction of materials, or by relying on secondary (non-virgin) materials (Zink and Geyer 2017). This narrow flow is also slowed down as it passes through the economy by different product-life extension activities such as repair, refurbishment or remanufacturing (Stahel and Clift 2015). At the end of the use-life of products, resource flows are closed by recovering the products and materials before they end up in landfill, the ocean or simply being burned. This recovery provides the opportunity to give the right treatment to the different materials either re-incorporating them into the economy or returning them safely to

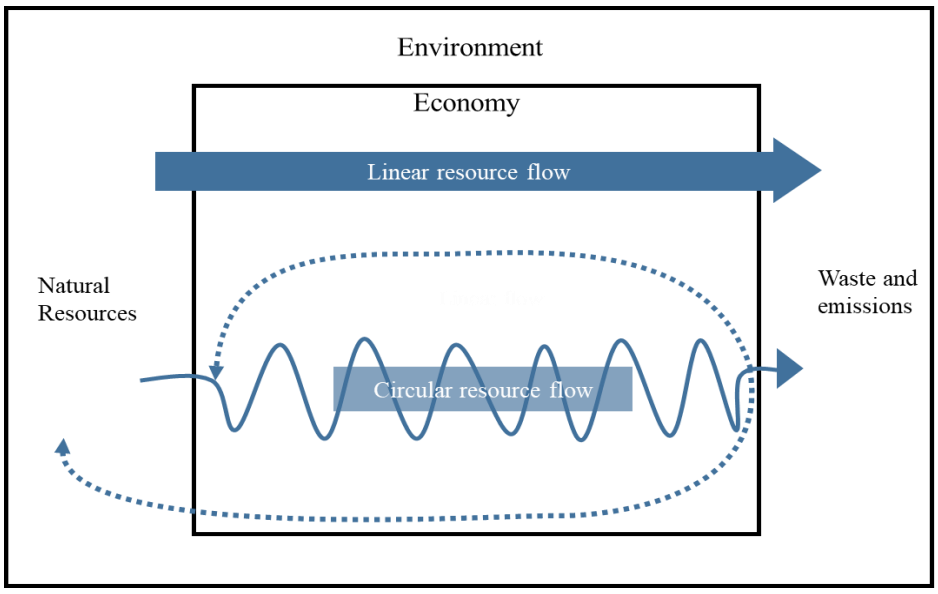

Figure 1: Resource flows in linear and a circular economy. Source: Own elaboration

nature (Braungart, McDonough, and Bollinger 2007).

An economy could never become fully circular, however, "circularity" as a characteristic of the economy, is desirable (Zotti and Bigano 2019), especially since it holds the potential for reducing the demand for natural resources and waste generation (Prieto-Sandoval, Jaca, and Ormazabal 2018). In addition to environmental benefits, increased circularity has the potential for generation of employment by substituting energy intensive activities (e.g. mining), with labor intensive activities

(e.g. repair shops or waste recovery and sorting) (Stahel and Clift 2015). Furthermore, it can promote economic stability, particularly for economies dependent on materials import, since it decreases the dependency on imports of critical materials (Ellen MacArthur Foundation 2015).

Most agree that circularity can only be achieved by a systemic redesign of systems of production and consumption (Kirchherr, Reike, and Hekkert 2017). From the private sector perspective, this includes rethinking products (Bocken *et al.*, 2016) services (Tukker 2004) the and business models that allow for the production and consumption (Urbinati, Chiaroni, and Chiesa 2017). In parallel, social aspects such as consumer practices (Camacho-Otero, Boks, and Pettersen 2018) and regulatory frameworks (Milios 2017) also require a reconfiguration aligned with circularity flows. This kind of multi-level redesign of the economy is based on partnerships across multiple stakeholders such as enterprises, governments and communities, where each of these actors have different roles to play (BSI 2016).

2) The "how-to" for circularity at enterprises

For more than 50 years, the CE has been associated with the "3R" framework, which stands for reuse, remanufacture and recycle (Stahel and Clift 2015). This framework represents the result of interactions between multiple supply chain actors such as customers, manufacturers and recyclers which circulate materials creating "loops". Nowadays, a greater variety of loops, including more stakeholders, have been explored and put into practice (Ghisellini, Cialani, and Ulgiati 2016). This is due in part because several schools of thoughts and disciplinary approaches have influenced the current understanding of the CE, including eco-design, performance economy, cleaner production, etc. (Homrich et al. 2017).

In other words, the original "3R" framework has been greatly expanded with additional product-life extension actions which include sharing, repurposing and cascading (Reike, Vermeulen, and Witjes 2017). Nevertheless, the approach towards circularity remains the same: interactions between multiple supply chain actors allowing for the formation of "loops" which can promote the preservation of value from materials in the economy. Collectively, all these potential loops can be considered as '*circularity strategies'* (Zotti and Bigano 2019).

Table 1 contains a list of strategies relevant for promoting circularity at an enterprise level. The list is inspired by the 10R typology[1] introduced by Reike, Vermeulen, and Witjes (2017) and modified based on contributions from additional frameworks (The Ellen MacArthur Foundation 2015; Kalmykova, Sadagopan, and Rosado 2017; Lüdeke-Freund, Gold, and Bocken 2018). The list of strategies presented below are framed from the perspective of a focal enterprise, or as individual actions from a single perspective. However, they should not be confused with isolated tasks, since these often involve actions both inside and outside of the walls of the focal enterprise. The table provides names and brief description of 12 strategies that enterprises can follow in order to close, narrow and slow material loops. These are categorized based on which product life-cycle phase they are most relevant. In addition, the table indicates what type of object (physical or otherwise) the strategy pertains, example of literature that deals with the topic as well as the potential material effect these strategies may lead

[1] This specific framework, which is published in a peer-reviewed journal, was chosen as a baseline since it was developed based on a systematic literature review and it is focused on strategies for implementation of CE at an enterprise level.

Product-life cycle phase	Circularity Strategy	Description	Object	Material Effect	Example reference
Design	**Circular Product Design**	Design strategies for durable products including **long life** (i.e. emotional, physical durability); **life extension** (i.e. repairable, remanufacturable); **flexibility** (i.e. upgradable, modular); **recyclability** (i.e. reduced hazardous materials, recovery/recyclability rate).	Design of products, consumer practices or interactions amongst various social actors	Narrow, Slow and close	(den Hollander, Bakker, and Hultink 2017) (Braungart, McDonough, and Bollinger 2007).
	Eco-sufficiency	A strategy in which the enterprise, through multiple aspects such as their product design, sales strategies, services or governance structure, aims to mitigating a consumerism behaviour of their customers and hence, reduce the absolute demand for resources			(N. M. P. Bocken and Short 2016)
	Market creation	Creates a market (digital or physical) which allows for interactions between consumers, enterprises or a combination of these actors. This markets can be of secondary raw materials or second-hand products.			(Kortmann and Piller 2016)
Production	**Industrial symbiosis**	Directs a waste stream from the production process into another companies production process	manufacturing process of products, either consumable (e.g. food based products) or durable (e.g. furniture)	Narrow	(Patricio et al. 2018)
	Secondary raw materials	Incorporates wasted products, components or non-virgin materials into its production			(Gaustad et al. 2018)
Use	**Product-as-a-service**	Provides access to products by leasing, renting or result oriented schemes. Ownership of the products remains with enterprise and customers become users.	Products that retain their integrity (i.e. used for the intended purposes they were manufactured.	Slow	(Tukker 2015)
	Product Life Extension	Service interventions that can extend the useful life of a product. For example, repair, replacing components, refurbishing, reconditioning and remanufacturing. Ownership remains with customer and the enterprise simply provides the life-extension service			(Moreno et al. 2016)
	Take-back	Collects or buy-back products with the aim to be sold to another costumer. Some			(Renswoude, Wolde, and

		service intervention might be required (e.g. repair). Ownership change, from costumer to enterprise.			Joustra 2015)
	Cascade	Sell products to a category of consumer requiring lower standards of quality. Change of ownership from enterprise to costumer.			(The Ellen MacArthur Foundation 2015)
Recovery	**Part harvesting**	Takes valuable components from wasted products (for example from recycling stations, demolition sites etc.)	Components and materials (once product reached obsolesce and will not be used as originally intended.	Close	(Reike, Vermeulen, and Witjes 2017)
	Biological recovery	Returns biological nutrients to nature (e.g. composting), creates bio-gas, or extracts their nutrients (e.g. biological extraction)			(Braungart, McDonough, and Bollinger 2007)
	Recycling	Recycles materials so they can be reintroduced in production processes.			(Moreno et al. 2016)

Table 1: Circularity Strategies

The circularity strategies presented in Figure 1 are combinations of design and business strategies; which, by definition, represent abstract plans and not "turn-key solutions" ready to be applied in any given context (Mintzberg 1987). In practice they need to be adjusted due to significant differences between trades and economic sectors and aligned with the conditions in which the enterprise operates (Lüdeke-Freund, Gold, and Bocken 2018). In other to understand the context in which these instruments of implementation of a CE unfold, the following section reviews the concept of Circular Business Models.

3) Circular Business Models: value creation through circularity

The concept of Circular Business Models can be used understand how do circular strategies unfold in practice. In other words, to shed light to the context in which enterprises can narrow, slow or close resource loops as part of their commercially oriented activities. While the concept of Business Model (BM) has multiple definitions, it can be considered as an aggregated and simplified representation of the general activities of an enterprise related to two major components: value creation activities towards generating products and services and the customer and market considerations (e.g. distribution channels, revenue structures etc.) that are relevant for obtaining or sustaining a competitive advantage (Wirtz et al. 2016). In other words, it describes the logic of how an enterprise creates value, capture value from customers in the form of revenue and sustains this position in the market.

Building upon that definition of business models several authors have provided definitions for a Circular Business Model (CBM) with no clear established consensus apparent (Lüdeke-Freund, Gold, and Bocken 2018; N. M. P. Bocken et al. 2014). The most specific definition of CBM is that of a business model that creates 'commercial' value by prolonging use-life of products, closing material loops (Nußholz 2018). Overall, the understanding of a CBM in this research is the following:

"A circular business model describes most important components related to the sustained process of creating and capturing value from by narrowing, closing or slowing material flows.

In other words, a CBM describes how a firm creates value to customers through circularity. This definition differences between sustained interactions involving consumers and limited time initiatives that may be aimed towards circularity. These sustained interactions can potentially generate environmental and social benefits and their scope is bounded (limited and promoted) by an institutional context". The remaining of the sections discusses some theoretical aspects of this definition of CBM.

An inter-organizational perspective

One of the core elements of CBM is that in order to create a CBM, it requires the sustained interaction of suppliers and customers (Rohrbeck, Konnertz, and Knab 2013). These characteristics can help differentiate between CBM and isolated or in-house initiatives aimed at environmental improvement such as efficient production processes s these, by themselves, do not represent a value proposition from the firm to their customers or involve their suppliers in their actions.

Urbinati, Chiaroni, and Chiesa (2017) developed a taxonomy that categorizes CBM based on whether the main interactions happen between the firm or its supply chain and/or customers. Specifically, a circular business model based on relationships between firm and customers is considered as *downstream* circularity. In turn, *upstream* circularity involves the firm and its supply chain and "full" circularity involves incorporating downstream and upstream circularity. Geissdoerfer *et al.* (2018) argued that incorporating both supply chain and customer allows for an optimal performance of a CBM, however collaboration across the entire supply chain is complicated considering that most enterprises have a limited influence in the full value chain (Ranta et al. 2018).

Institutional context

It is argued that most business models are inherently trapped in an institutional logic (rules, norms an regulations) aligned with the principles of a linear economy (Fischer and Pascucci 2017). In that same way, CBM are still bounded within this institutional context and it is a crucial element to understand which CBM are able to be developed and which are not.

This institutional context includes inter-dependence with other business models. For example, CBM based on collecting, repairing and re-selling mobile phones is dependent on the manufacturing of these devices, this is referred to as the business model ecology (Nancy Bocken, Boons, and Baldassarre 2019). In other words, some CBM may only be able to exist because there are non-circular BM in place.

Furthermore, from a regulatory perspective, CBM are subject supra-national national and even regional specific standards. This official rules may legally prohibit the development of a specific CBM such as trade bans of used clothing or waste exports. This formal rules also interact with unofficial local cultures and industry-specific practices which can become relevant elements that enable or hinder the development of specific CBM (Tura et al. 2018). Customer acceptance is also a crucial component on CBM as this are commonly regarded as practices that differ from the dominant market practices in the sector (Camacho-Otero, Boks, and Pettersen 2018).

Environmental and social benefits

One main discrepancy in the different understandings of CBM is regarding their potential for environmental and social value creation. Some have placed these two elements as inherent to a CBM, while others as potential consequences (Pieroni, McAloone, and Pigosso 2019). While it is undeniable that part of the attractiveness of the concept of a CBM is precisely in the fact that they hold the potential of creating social and environmental value while creating economic value, in this investigation, social and environmental value creation is treated as potential consequences, which require further analysis (outside of the scope of this project) to fully measure and confirm.

This consideration is taken because social value creation is dependent on the decisions taken by the firm in regards to how to conduct their operations what to do with the economic value created (Khmara and Kronenberg 2018). This will determine, if a CBM has positive effects on job creation or additional consumer value for example. Nevertheless, these are a function to the specific context of implementation. Furthermore, research is clear that environmental benefits are dependent on life-cycle analysis, the specific boundaries defined for their analysis, in addition to larger economic consideration related to what is commonly known as “rebound effects” which describe potential negative consequences of actions that initially can be perceived as beneficial from an environmental perspective (Zink and Geyer 2017).

II. Methodology

The research approach for this investigation was to identify and analyze – based on the analytical framework presented in the previous section - different SMEs from the Baltic sea region in order to present an empirically derived overview of the CBM currently available in distinct trades and sectors of the economy.

1) Search for cases

The approach for selecting cases followed a purposeful sampling approach (Emmel 2014) in which pragmatism and in consideration of the interests from the involved group are the main driver for selecting cases. This approach guarantees that the cases selected are able to provide relevant data for the research purpose, compared to for example random sampling.

During the process, all partners from CircularPP provided at least five examples of what they considered as best practices of circular SMEs from their corresponding countries focusing on the pre-selected categories: Information and Communication technologies (ICT), Furniture, Office or indoor equipment, Textiles/clothing, Playground infrastructure, Catering services, Lighting. The categories were determined in order to be relevant for the pilot projects developed during the CircularPP and to based on general interests from the municipalities' participating in the project. The suggestions included name of the company, country of operations/origin, brief description and product group.

2) Case selection

Following the partner's suggestions, each case was analyzed in order to determine if they could be considered as a circular business model. This identification was done by answering the question: "is the firm following one or more of the different circularity strategies discussed in the previous section (table 1)?" The question was answered based reviewing the information available on the firms' website, and if available CSR reports and other relevant documents, such as news or scientific articles addressing the company. This type of qualitative proxy indicators are useful for simple categorizations, and in this case are necessary, since there are no available indicators for circularity of business models (Simone and Alberg 2020)

Some suggested cases were dismissed due to the company was no longer in operation, there was not sufficient information available on their website to determine if they were following a circular strategy, or they were *clearly* considered as trans-national corporations that did not meet the "Small and Medium Enterprise" criteria[2].

3) Case analysis

In addition to the secondary sources (e.g. website, CSR reports and other documents), primary data collection was also conducted following two approaches, semi-structured interviews (face-to-face) and structured (written) interviews. The structured interviews were direct questionnaires sent to the representatives of the firms through email. In total, 50 websites were analyzed, 14 semi-structured interviews were conducted, 9 structured questionnaires were sent and responded and eight external documents were reviewed. The details for each case data collection are provide in the Annex.

Semi-structured interviews were conducted with representatives of the firms that could explain elements related to the circularity aspects of the business model. This type of interview is an

[2] The process of determining what accounts as an SME in Europe is complicated and requires sensitive information (e.g. turnover, employee count, balance) that is hardly available on websites. Therefore, the authors criteria was used to determine which cases were clearly out of the SME scope.

adequate research tool to explore experiences such as complex social interactions (King 2004). These interviews followed an interview guide, available in the Annex, which contained broad themes in order to allow space for the interviewer to make follow-up questions and allows interviewees to potentially bring forth critical aspects that might not have been considered when designing the interview guide, another strength of semi-structured interview method (King 2004). Overall, these interviews were used to construct ten individual cases with additional relevant information. The selection of these cases was based on a balance between geographical scope, product groups, uniqueness of their business model and willingness to be interviewed.

III. Results

In this section, 50 different cases of SMEs operating a circular business model are introduced. The cases are arranged in sub-sections for each category group. Each subsection contains an introduction to the category group and a table that includes relevant information of the cases analysed for that category. The information includes value chain position or main activities, a brief description and the main circularity strategies associated with that case. The cases are not mentioned by name; instead, a code is used in both the table and the text. The code contains a letter, representing the country from which the case was obtained and a numeric indicator.

Code	Value Chain position/ Main activities	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling

Table 2: Heading of the summary table included in each category group

From the 50 cases analysed, 10 cases are presented separately with further information, namely a main barriers and benefits of the CBM. Each section with an empirically derived overview of the CBM available for that category.

1) Food and food-based products

The category of food and food based products is mostly represented by the food value chain, which includes several industries and sectors aimed at producing unprocessed, partially or fully processed food intended for human consumption (Stenmarck et al. 2016). However, other supply chains such as the biomaterials industry are also included. The traditional flow in the supply chain begins with food producers (farmers, fisheries, etc.) in charge of supplying produce (fruits, vegetables, diary, meat etc.) to enterprises downstream in the supply chain such as the food and beverage industry, wholesalers, retailers and food service organizations (e.g. restaurants/catering) (DG Agriculture and Rural Development 2017).

Code	Value Chain position	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling
Food and food-based products														
R1	Food Producer	Certified organic farm	X											
P1	Processing	Production of biodegradable dishes and cutlery from natural wheat bran	X				X							
D11	Processing	Use food surplus (apples) to produce a natural, biodegradable leather	X				X						X	
S6	Processing	Juice production enterprise based on "wasted" fruits and vegetables from supermarkets					X					X		
P4														
S8	Food services	Restaurant and catering services based on second/hand ingredients					X					X		
S9														
N13	Secondary Market/Food services	Restaurant and catering services based on second/hand ingredients. Retailer of second hand ingredients		X			X				X			
F9	Secondary Market	Connects suppliers (café, restaurants, grocery shops) that have "leftover" food products, with potential customers offering an interface system for interaction			X									
S4					X									
L5	Retail	Zero-waste (bulk) retail shop		X										

D7	Waste management/Processing*	Recovery of spent coffee grounds and processing in bio-refinery to produce coffee oil and coffee flour.										X	X	

Table 3: cases analysed in the category group of food and food based products:

The foundation of a circular food industry

Based on the cases reviewed, a case of CBM for food production enterprises is focused on organic production in order to provide safe inputs that can be used downstream in the supply chain (**R1**). This production technique avoids chemicals and pesticides which creates the foundations for a circular system in which products and materials can be circulated and reincorporated safely into the ecological system (Braungart, McDonough, and Bollinger 2007).

CBM based on secondary flows

All across the supply chain, secondary flows and waste is generated. These flows can be used as secondary raw materials in order to develop a CBM.. Three main secondary flows are distinguished:

1. By-products: unintended produce generated during the production of a main product, mostly generated by food producers and the food and beverage industry.
2. Class II products: edible and commercially valuable produce (e.g. fruits and vegetables) that are considered of lower quality due to size, maturity and esthetic reasons.
3. Donations: Produce or processed food products that were destined for waste but instead were donated, or allowed to be collected by different organizations. There are multiple situations in which edible products would be destined for waste, such as: products reaching "best-before-date", over-stocking by supermarkets, re-branding of products and need to take out old products from market, products packaged in pre-set quantities in which one of the products is damaged but the rest are not or produce that farmers cannot sell due to aesthetic reasons

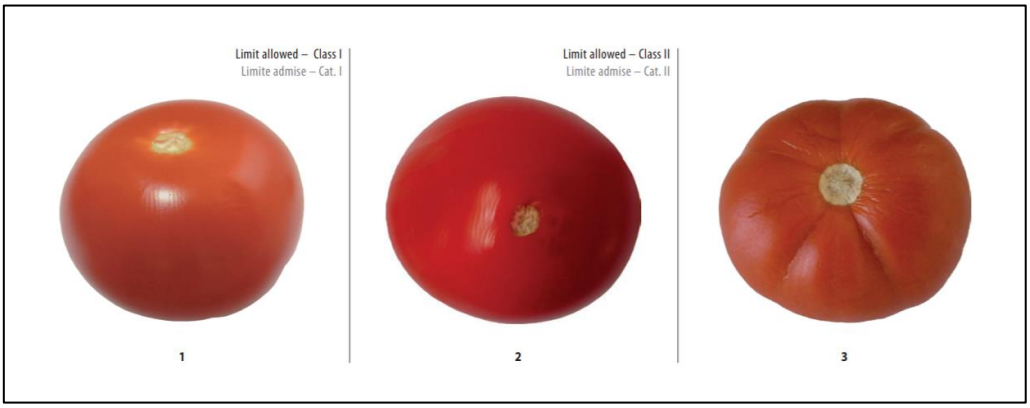

Figure 2: Three tomatoes differentiated in Class I, Class II and Class III based on the characteristic "fresh in appearance". Image taken from the OECD International Standard for fruit and vegetables (OECD 2019)

Some CBM based on secondary flows are for example **P1**, which provides a substitute for single use plastic cutlery by using a by-product from wheat bran producers and manufacturing with it biodegradable single use cutlery and dishes.. Similarly, **D11** uses apple pressings, a by-product of from cider industry, to produce leather-like textiles, which can be used as a viable bio-based

material. In terms of donations, some processing enterprises such **S6** and **P4** collect fruits and vegetables destined to waste from supermarkets and restaurants, which then are used as ingredients in the production of juices. In turn, class II products are slightly different as they still hold a commercial value (although slightly lower that class I products) and cases like **S8** and **S9** are examples of food service enterprises (e.g. restaurants and catering services) that prepare meals mainly based on class II and donated products.

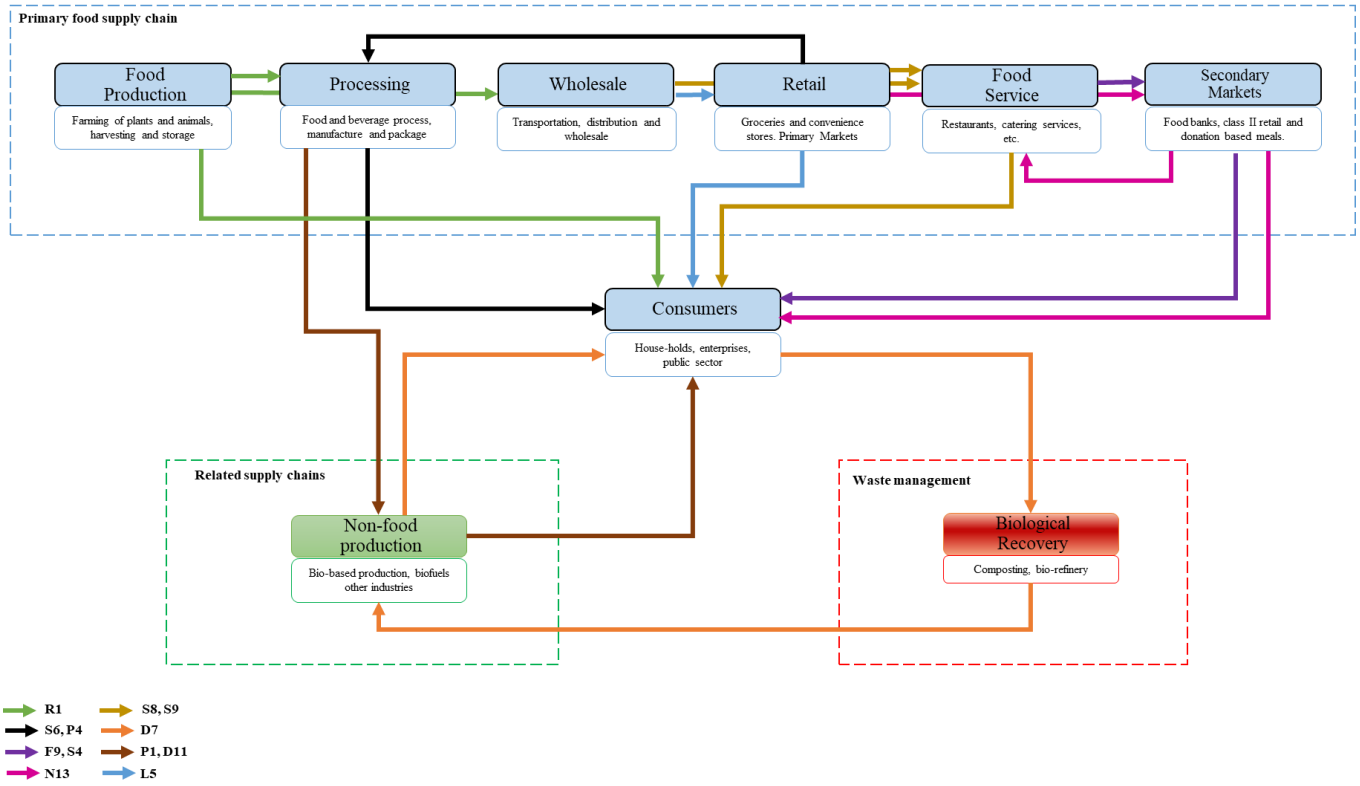

Figure 3: Supply chain map in which different actors are connected by material flows. Each colour arrowed represent one CBM and it displays the material interactions and actors involved in that particular CBM. Source: own elaboration

Creating markets

Class II and donated produce tend to have a less reliable supply compared to virgin raw materials and Class I products. Therefore, enterprises that rely on them have to manage the uncertainty of the distribution channels and the variable availability of any given time. Due to this situation, another form of CBM is creating a secondary markets for Class II and donation flows which can facilitate their retail and distribution. Such is the case of **N13** that collects secondary raw materials through their established partnerships and makes them available as wholesale distributor to other enterprises, essentially creating a secondary market. This type of actor in the food supply chain is known as back-line organization (European Commission 2017a) .

A similar secondary market is also created by **F9** and **S4,** however this one is at the level of food service. These two firms create digital markets for meals that are unsold at the end of the day in restaurants or cafes. This newly created market allows food service providers and consumers to interact and get mutual benefits. Suppliers of meals can potentially obtain additional revenues for

previously unsold meals that would have been discarded as waste and consumers get access to discount meals through a user-friendly interface.

Engaging consumers

It is estimated that 20% of the food produced is wasted in the EU (Stenmarck et al. 2016). The retail sector is considered the lowest contributor with an estimated of 150 and 200 million tons per year- around 5% of the total food waste (Stenmarck et al. 2016). However, while food waste may not be critical at the retail sector, there are retail practices that can help reduce food waste further down the supply chain, namely at the consumer level. Such is the case of **L5**, whose zero packaging and bulk offering of products allows consumers to purchase more accurately to their needs, which can help reduce food waste at the household level. Similarly, **N13** is directly involved in educating consumers in conservation techniques in the kitchen, which is another initiative that can help reduce household food waste.

Valuable waste

Following the CE principle, products components and materials should remain in the economy at its highest value (Geissdoerfer et al. 2017), in the case of food, this translates in a priority of rescuing edible food for human consumption, or if not possible, recovered for animal feed. However, sometimes these options are not possible (e.g. inedible parts of animals, rotten fruits and vegetables etc.) and waste management becomes necessary (Commission for Environmental Cooperation 2017).

Food waste can be treated in several ways such as composting and biogas generation, incineration or landfill (Stenmarck et al. 2016). A preferable option is to recover some of the valuable nutrients in the waste fraction. Such is the case of **D7** who collects wasted coffee grounds from hotels and restaurants and through a process of biological recovery; they obtain raw materials for producing coffee-based products.

Case: Sopköket

Country: Sweden

Description: Sopköket is a restaurant and catering business that prepares meals based on partly rescued and surplus ingredients from supermarkets and wholesalers.

Figure 4: Sopköket staff at the restaurant premises. Image provided by Sopköket

Main Strategy: Secondary Raw materials

Circularity of business model:

Sopköket circularity is based on narrowing food flows by incorporating ingredients that were destined to be waste but remain in suitable conditions for human consumption. They are also focus on eliminating their own waste, by redistributing leftover meals to people in need or amongst their employees and their relatives. Lastly, they operate their own compost to minimize waste generation and just recently began producing a fertilizer for their rooftop garden.

Other benefits:

Running this type of CBM provides several advantages. Firstly, their approach has a clear focus on sustainability (in particular eliminating food waste), which allows them to find partnerships with like-minded enterprises, such as organic or local food retailers, in order to get access to donated or class II produce. In addition to attract a growing niche of sustainability-sensitive consumers.

Another benefit is that they have lower raw materials costs since some of the ingredients used are donated or purchased at a discount price. However, this business model also requires a larger work-force compared to traditional restaurants and Sopköket focuses on providing opportunities for immigrants in Stockholm to enter the job market. Lastly, they communicate the story of the rescued ingredients, for example the place where they were collected. This action not only raises awareness and promote a stronger connection between their customers and their food but also provides their customers reassurance that their food was not taken from a garbage bin.

> "We have a lot higher salary costs because it takes much longer time to deal with ingredients at our disposal due to sorting, going and picking up the ingredients at the store, then sorting it and cleaning and creating new recipies every day…Then of course we buy other things in a normal way to complement the things we rescue and be able to prepare the meal…" Fillip, Founder of Sopköket

Main Barriers:

Their main challenges are related to higher salary costs, since it takes longer time to deal with ingredients at their disposal for sorting and cleaning and creating new recipies every day. In addition, even though they have stablished partnerships with supermarkets with specific dates and times for pick-up, they have more complicated logistics than traditional restaurants. In particular, health regulations that require detailed registration of every item donated represent a barrier for establishing collaboration with some members of the retail sector because, this in turn, requires supermarkets to allocate more resources on additional work-force to deal with the established requirements.

Case: Turza

Country: Latvia

Description: Turza is zero-waste, package free, self-service shop, where it is possible to buy everyday products in bulk. Product selection includes oils, teas, plastic-free body care, household products, and a selection of daily life food products.

Main Strategy: Eco-efficiency

Figure 5: Inside one of Turza locations. Image provided by Turza

Circularity of business model:

Turza narrows material flows in two different ways. First, it gives customers a chance to buy the specific desired quantities which helps reduce the potential of overstocking and eventual food waste at the household level. Secondly, it promotes a "slow" shopping culture by having consumers taking time to measure and pack products inside the store in the containers that they brought, which creates the conditions for a more conscious decision-making while buying.

Furthermore, it reduces demand for plastic and generation of plastic waste by offering package free solution. This includes both for their customers but also for their suppliers, whom have responded positively to Turza's requests for bulk delivery or taking back the containers in which they supply their products.

Other benefits:

Turza can get access to lower prices from suppliers when buying large quantities of products that are traditionally sold in small packages (e.g. nuts, oil, coffee, etc.) and potentially even lower prices when some suppliers recognize that is cheaper for them to deliver in bulk and without packaging. This savings translate into lower prices for Turza's customer on most products that usually come in package.

Furthermore, Madara, the founder of Turza says she has observed increase interest into bulk retail. Not only from customer interested in zero-waste philosophy but also customers that have recognized that bulk shopping allows them to save money.

"Offering products on bulk you give a chance to people to buy the product as much as they need, even if it's just a few grams…shopping is becoming a midnfull process for a lot of people." Madara, Founder of Turza

Main Barriers:

The main barrier for further development of this business model is mainly related to cultural barriers from consumers. These include misconceptions regarding bulk products lacking hygiene, lack of variety of brands and consumers wishing to spend as little time possible doing their shopping.

Furthermore, market conditions for vegetables and fruits make it impossible for Turza to compete in terms of prices with super-markets buying large quantities of fruit and vegetables every day, therefore these products can be more expensive.

ii. Built Environment

The “Built environment” is a category that includes a broad range of activities related to designing, constructing, operating and potentially demolishing infrastructures (e.g. houses, offices, and other type of facilities). In the context of CE, the construction sector has crucial economic and material implications. It represents approximately 8% of the EUs GDP and provides 10% of all employment (Reinstaller 2016). Furthermore, it consumes around 40% of materials and it generates between 25-30% of all waste (Thelen et al. 2018). This economic sector is more similar to a project-based activity than a routine manufacturing task. Its complexity results partly from the variety of actors and sub-economic activities involved and the inherent characteristics of the main “product” (i.e. infrastructures).

A complex economic sector

Buildings (and other facilities) are complex structures which can be considered as an assembly of multiple “layers”, each comprised of unique materials and components (Brand 1994). This is significant to circularity, since these “layers” have diverse lifetime spans. For example internal layers in a building such as carpeting or furniture might last between 5-10 years, while the plan layout and façade may be changed after 15 years, roofing renovation at 20 years and the structure of the building can be made to hold for more than 70 years (Thelen et al. 2018). Furthermore, in the built environment, multiple actors coalesce at different points in time (Pomponi and Moncaster 2017).

It has been highlighted that the challenges and opportunities for circularity in the built environment depend on whether one is dealing with an existing facility (which may not have been originally designed following circularity principles) or a potential facility, which can be design with the state-of-the-art knowledge, however it would require a large amount of materials (Thelen et al. 2018).

Figure 3 depicts the main sub-economic activities of the construction value chain in relation to the three main life-cycle phases of infrastructures, includin beginning of life (i.e. construction of the infrastructure), middle of life (i.e. use and operation of the infrastructure) and end-of-life (i.e. both demolition or renovation and repurposing activities) (Reinstaller 2016). The main sub-economic activities considered are:

1. Construction: includes all type of on-site works, from site preparation and building of the infrastructure.
2. Construction services: includes architecture, design, and other parallel services.
3. Construction supply: includes suppliers of raw materials (e.g. gravel, sand, bricks) and specialized components for construction (e.g. insulation panels, illumination systems, etc.).
4. Operation of facilities: includes management and maintenance of facilities thorough the time they are used.
5. Renovation or repurposing: includes works conducted to the infrastructure that prolong its “use life”, either for its original purpose (renovation) or for a different function (repurposing).
6. Demolition and recovery: includes all activities at the end of life of the infrastructure, including (selective) demolition, decommissioning and site remediation

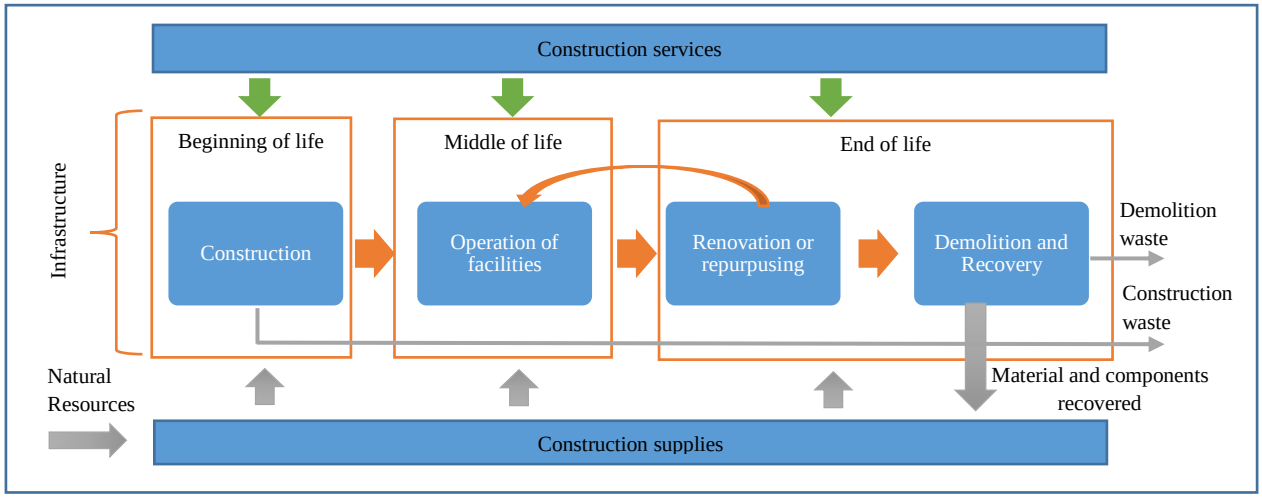

Figure 6: Main economic activities (blue rectangles) divided by life cycle stages (orange rectangle) of the infrastructure. The orange arrows represent a transition in life cycle phase. The green arrow signals a supply of services. Grey arrows signal material and waste flows. Source: Own elaboration

The cases considered in this section are diverse, as they pertain to almost all the different sub-economic activities related to construction, as well as the different life-cycle stages of infrastructure. Seen in isolation, they might be difficult to relate to each other, however, the model is expected to help position and contextualize these different CBM considered in the analysis for this category group.

Code	Value Chain position	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling
Built Environment														
N12	Construction Services	Consultancy/design firm focused on sustainable (circular flows)	X		X		X							
D12	Construction Supply	Insulation panels with a C2C silver level certification	X						X	X				
D3	Construction Supply	C2C certified carpet tiles	X				X							
N4	Construction Supply	C2C certified carpet tiles and take back system	X			X				X		X		
S10	Operation of facilities	Company specialized in modular luminaries and lighting-as-a-service programs	X				X	X				X		
S1	Operation of facilities	Signs (electronic) that are designed to be disassembled, re-	X					X	X					

		used and re-cycled												
D4	Renovation or repurposing	Retrofitting current luminaries with LED technology	X				X		X			X		
D5	Demolition and recovery	Upcycling of recovered bricks from construction					X					X		
D10	Demolition and recovery	Artificial turf recycling company												X

Table 4: cases analysed in the category group of built environment

Construction and Demolition: a market for materials

Waste-valorization is one of the cornerstones of the CE and different category groups are faced with unique challenges in their quest for tapping into the value of waste streams. Particularly in the construction sector, **N12** address this challenge by facilitating and enhancing the market for secondary construction materials. They do so with the help of an online platform that maps the different resource flows available in the region, which facilitates interactions between supply and demand of construction waste and construction materials.

Construction supply: circularity of individual components

Insulation panels, luminaries, electronic signs and carpeting tiles. These are all specialized components that are relevant to the inner layers of building. As such, their circularity (at a product level) is important to the total building circularity. At the product level, modularity and ability to incorporate non-virgin materials are the keys for circularity.

Being able to dis-assemble their own products incentivizes companies to recover them after their customers no longer are using them. Then, these products become valuable resources which companies can incorporate into their production process reducing the demand for virgin materials. Such is the case of **D12**, which takes back old insulation panels from their customer when they purchase new panels from them. Furthermore, through the Cradle-to-Cradle certification, D12 keeps track, communicates and set a paths for improved circularity in some of their specific products.

Similarly, **D3** and **N4**, both add on to the building circularity by means of their own carpets and rugs. Both companies also offer some of their products with a Cradle-to-Cradle certification. Particularly, D3 specializes in incorporating recycled materials (such as fishing nets, plastic bottles or recycled yarn) into their products. For their part, N4 has established a system in which they collect old carpets (their own and from competitors), separate them into two streams of resources (yarn and bitumen). The yarn is reintroduced as feedstock into their suppliers' production process and the bitumen is used by the road and roofing industry, generating an industrial symbiosis.

Operation of facilities: Product service systems for circularity

A circular product design based on modularity and high quality materials, results in long lasting products. This provides an incentive for companies to switch from selling their products into offering them as a service. Particularly **S1** with electronic signs, and **S10** with luminaries and lighting, have adopted a product-service-system model in which their customer no longer purchase their products but in turn, pay for the result desired. In these cases, the results provided are related to keeping a specific level of illumination (S10) and the management of signs inside a facility (S1).

Renovation and repurposing: life extension of inner layers

Firms like **D4** focus their circularity in renovation, in other words, extending the use-life of products and preventing them from going to waste. Specifically, retrofit old luminaries with energy efficient LED technology. This way, resources are saved by not having to purchase new luminaries and the aesthetics of the building are preserved. D4 also *harvest parts* and components from old or wasted (third-party) products like old luminaries or television screens and incorporate them into their own production line.

Demolition and recovery: resources at the end-of-life of buildings

Construction and demolition waste flows includes concrete, bricks, metals, tiles ceramics, plastics and excavated soil, all of which have the potential to be recycled, but often end up simply being used as material filling on other construction projects (Thelen et al. 2018). This is down-cycling, an activity of low-added value, both in economic and environmental terms. A circular solution can be distinguished in the cases of **D5** and **D10**, two companies which undertake on-site decommissioning of buildings and houses (D5); and artificial turf facilities (D10) respectively. Both of these cases make use of their own technology which allows them to conduct a recycling processes in which they are able to recover high value components (e.g. bricks) or pure raw materials (e.g. high-quality turf yarns).

Case: Superuse Studios

Country: Netherlands

Description: Superuse Studios started as an architectural firm in 1994, since then, they have focused on incorporating available regional flows (e.g. existing materials, water, energy, data) into their designs. Today, one of their main business models is related to facilitating, through a digital platform, the exchange of resource flows (particularly focusing on construction materials and industry flows) in specific regions or industrial zones.

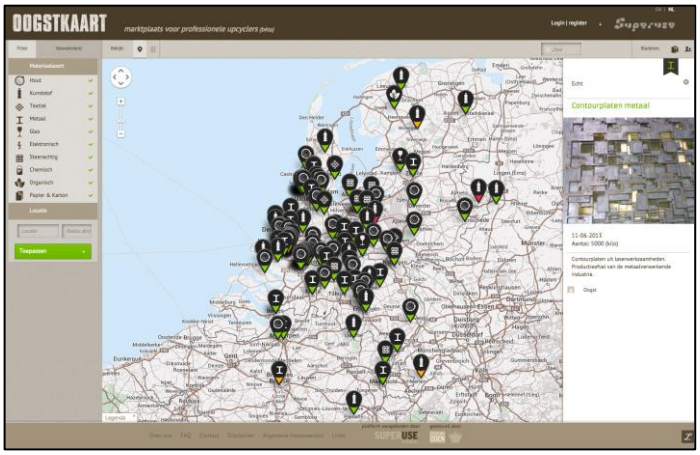

Figure 8: Screenshot from digital platform mapping regional resource availability. Image provided by Superuse

Main Strategy: Market creation and secondary raw materials

Circularity of business model:

Super-use closes construction material flows through the creation of a market for secondary materials that facilitates the interaction between construction waste suppliers and potential customers. This is achieved by mapping, visualizing and sometimes brokering the exchange of resource flows, within a limited spatial dimension (e.g. region or economic area) for the organizations that sign up to their platform. Additionally, in the projects that they develop, they narrow multiple waste flows by designing their own projects focusing on the available resources (and waste) that are available. For example, using wasted parts from wind turbines to create the main structures of a playground project.

"Our creativity comes from a clever combination of the demands, requierements, available materials and obstacles on the site. It is a different starting point. Jan Jongert, Founder of Superuse Studios"

Other benefits: Reclaiming building materials is a relatively known practice. These particular waste streams comes in large quantifiable flows, which facilitates the planning accordingly to their use. For example, based on the installed capacity of energy generation windmills, it is possible to anticipate for a steady income of "wasted" blades in the upcoming years. Furthermore, at a material level, they do not differ greatly between virgin and secondary resources; therefore, they can easily be re-adopted.

Main Barriers:

Utilizing "wasted" construction materials presents a series of inherent barriers. From a logistics perspective, construction materials are constrained by tight schedules. In other words, building have to be demolished whitin a certain time. Due to the volume of this resource flows, the costs associated with potentially storing or warehousing is too high, therefore, it is crucial to find potential application for this materials whitin that time restriction.

Furthermore, unlike other commodities, secondary construction materials cannot be based on business models in which a company retains ownership of these materials. This is because, they usually have a long use-life, therefore, it is very difficult to predict the value the material will have in the future, in fact, this value is almost entirely dependent on finding demand for the material within the timeframe that it becomes available.

Other barriers highlighted are related to the additional labor required to incorporate reclaimed materials into a design. This situation, coupled with the imbalanced tax burden on labor compared to tax on new raw materials, makes it very difficult to compete with designs entirely focused on cheap materials. Lastly, related to participating in governmental projects, the use of reclaimed regional construction materials requires flexibility in the initial phases, particularly in the design proposal, which often times, public procurement process do not support.

Case: Accus

Country: Sweden

Description: Accus is a company specialized in providing signage (with or without illumination) for branding, way-finding and overall visual communication in buildings and facilities. Their business model include selling or renting of individual signage. Recently, they have begun collaborating with facility owners and operators in order to supply signage "as a service" providing continuous maintenance and adjustment of all signage requirements in the facility.

Figure 9: Sign from Accus which highlights the modular design. The frames, components and circuits are displayed separately as they are all interchangeable. Image provided by Accus

Main strategy: Product design, product-service system and product-life extension

***Circularity of business model*:**

Accus slows down resource flows used in the manufacturing of signage including plastics and electrical components, firstly by designing products in a modular way so these can be maintained and adjusted to changing environments. In addition they take back signage from their customers and reuse them in other projects. Furthermore, they can keep ownership of their products essentially providing signage as a service. In this arrangement, facility owners are their customers and tenants of buildings become users of the signs. Lastly, they also narrow material flows by incorporating recycled materials in the manufacturing process of their products.

"We are hoping that there would be better criteria in the future, that municipalities would have a more life-cycle thinking and value competences that you need to provide a sustainable service"
André Zandelin - Accus CEO

***Other benefits*:** The CBM of Accus allows their customers to meet their needs of signage and visual communication with a reduced environmental impact compared to conventional disposable products. To Accus, their circular product design allows them to use their products for several cycles, not only with one customer and eventually recycle their products once they cannot be re-used. Signs, particularly those used on the outside of buildings, have a fixed position and are relatively on inaccessible locations, therefore, this facilitates Accus keeping track of their own products and potentially recovering them when their users no longer need them.

Main Barriers:

Signs, specifically the branding ones, require a relatively high degree of aesthetics and uniqueness in their design. Sometimes this can be at odds with circular design, modularity and re-usability. Furthermore, implementing innovative designs that include re-used materials, in addition, to providing a constant maintenance service and adjustment, involves higher costs. Therefore, it is difficult to compete in bidding processes against suppliers who focus on cheap disposable materials, when price is the only criteria for selection.

iii. Furniture

The furniture sector involves a supply chain where several actors interact. From producers of wood, and metal, to component manufacturers (e.g. textiles, plastic components); designers and furniture manufacturers; distributors and retailers. Together, they produce different types of furniture, including wood-based, kitchen, mattresses, metal furniture, non-upholstered and upholstered seats (Forrest et al. 2017; White 2018). The main environmental concerns related to the furniture industry are waste generation, reliance on virgin raw materials (wood, metal and plastics), and the use of chemical, dyes, adhesives and coatings in the production process (Barbaritano, Bravi, and Savelli 2019).

In the EU, it is estimated that 80% to 90% of furniture waste is incinerated or sent to landfill, with less than 10% being recycled and re-manufacturing activities currently representing 0.1% of the industry (Forrest et al. 2017). This indicates the opportunity to develop CBM in this sector, particularly related to product life extension. There are various barriers faced in regards to remanufacturing including changing consumer preferences in regards to design and materials, unreliability of product supply and high labor costs of manual disassembly (Grösser 2017).

Code	Value Chain position	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling
¨Furniture														
D13	Design/Manufacturer	Furniture that is bamboo-based and painted with natural methods	X											
P5	Design/Remanufacturer	Collect non-recyclable spare parts from wasted automobiles to create various types of indoor equipment	X				X					X		
D8	Remanufacturer	Social enterprise focused on handcraft workshop based on recycled materials.					X					X		
D15	Design/manufacturer	Furniture design based on recycled or sustainable sourced materials (ocean plastic waste and recycled steel).	X				X			X		X		
S7	Distributor/retail	Market creation for remanufactured furniture		X	X					X				
D6	Design/(re) manufacturer / Retail	High quality furniture with a take-back system	X						X	X	X			
F8	Design/Remanufacture/Retail	Furniture services (new, remanufacture, renting, collection)	X					X		X	X			

N8	Design/Manufacturer/Remanufacturer	Workspace facility management	X				X	X	X	X				

Table 5: cases analysed in the category group of furniture

Material choices in furniture design

These environmental issues are more efficiently adressed when considered from the stage of product desig, particularly in the choice of materials. Such is the case of **D13**, a company that designs furniture based on FSC certified bamboo-wood which natural renovation cycle (and carbon footprint) is lower than alternative wood sources such as pine or cedar. Additionally, they limit the use of hazardous chemicals by using natural painting methods, water based dyes and adhesives. This strategy towards circularity is important since it sets the foundation for safe circulation of products and materials.

Waste as raw materials

Collecting "wasted" wood, plastics and metals is an approach to close material flows in the furniture industry. Relevant examples of this practice are **P5**, **D8** and **D15**. These three organizations collect parts from waste streams and incorporate them into their production as secondary raw materials. Each enterprise focuses on a distinct market segment and a unique waste stream:

- In particular, **P5** focuses on high-end handcrafted metal furniture. They try to give metal waste a conscious, modern and aesthetic design by using old automobile parts, which unique shape provides the foundation for unique furniture designs. The use of these pre-fabricated metal pieces substitutes the intensive energy process of metal folding.
- **D8** mainly works with wooden furniture for specific commissioned projects; they rely on collecting "waste" wood, furniture and various other components and incorporating them in their projects.
- Lastly, **D15** focuses on using recycled materials, particularly ocean plastic waste in the design and production of their furniture products.

Furthermore, each of these cases display relevant aspects of circularity that go beyond material aspects. **P5** incorporates a form of information transparency in which their products have a "material passport" that can help trace down to their origin. **D8,** as a social enterprise, provides labor opportunities for young people in risk of social exclusion thanks in part to the labor-intensive nature of furniture remanufacturing.

Facilitating Interactions

Circularity in the furniture sector can also be promoted by facilitating interactions. Such is the case of **S7**, which part of its business model is based on creating a market that facilitates the interaction between supply and demand of refurbished furniture. They do so, in two main ways. Firstly, they have a web-based marketplace where one can purchase remanufactured furniture; secondly, they can facilitate the interactions between organizations interested in refurbishing their own furniture.

Extending the life of furniture

One way to slow down the flow of furniture into landfill or incineration facilities is by collecting furniture at the end of their use life and perform different service interventions which prolong their useful life. This type of activities are normally performed by re-manufacturing and repair shops (Krystofik et al. 2018). Two cases, **D6** and **F8**, specialized in take-back of their own furniture and

collection of other company's furniture. This services are offered in addition to designing and manufacturing their own furniture following circular design principles.

Once they take back the furniture, they can refurbish it (e.g. replace worn-out parts, upholster, aesthetic changes etc.) and re-sell it. Refurbishment can also be done for the same customer; in this case, the furniture remains with its original user. Additional components to the CBM are related to donations of re-manufactured furniture that cannot be sold (D6) and short-term rental of furniture (F8).

Holistic approach: office furniture management

N8 business model has a more holistic perspective of circularity in which several phases of the supply chain are involved, including design, (re)manufacturing practices but also use-phase services and recovery. In summary, N8 provides a full workspace management service that includes, design, provision of furniture, maintenance services and eventual take-back. The modular design of their furniture facilitates disassembly and re-introducing collected parts in their own production process. Service contract creates an incentive to N8 to design modular, long lasting furniture that is easily repairable. This type of CBM requires frequent interaction with their customers in order to understand and satisfy their needs more efficiently.

Case: HOLMRIS B8 Circular

Country: Denmark

Description: HOLMRIS B8 is a company specialized in interior design and furniture solutions in four main segments: office, learning, hospitality and care. Part of their business model, operated by HOLMRIS B8 Circular, involves collection and refurbishment of used furniture.

Main Strategy: Product-life extension, Take-back and Cascading

Figure 10: Changing frames is part of the refurbishing process of furniture conducted at HOLMRIS B8 circular. Source: Jan Jul Søndergaard

Circularity of business model:

The circularity of HOLMRIS B8 Circular is based on slowing material flows by prolonging the use-life of furniture. They accomplish this in multiple ways, including: 1) extend the life of the furniture of their own customers through refurbishing services 2) acquire (or even purchase) used furniture, which then is refurbished and re-sold. What cannot be sold, is donated through their own network of charity organizations network and 3) offer a rental option for working stations or temporary office solutions. In addition, they close material flows by sorting and preparing for recycling the furniture that is unable to be sold or donated. This prevents valuable resources, such as metal and wood, from being landfilled or incinerated.

Other benefits:

The CBM operated by HOLMRIS B8 Circular brings about multiple benefits to the different customer than can be engaged through their activities. The main ones are:

1) Customers wishing to purchase refurbished furniture get an opportunity to access high quality furniture at a lower price compared to market standards.
2) Customers wishing to get rid of old furniture save on collection and disposal costs. They can even get some money for their old furniture, if it still has a high residual value. Furthermore, additional costs savings can be achieved when combining logistics of moving in new furniture and moving out old furniture. These customers also get an environmental report that describes the handling process and destination of their disposed furniture i.e. what is resold, what is donated and to whom, as well as how much is send for recycling.
3) Customers who would like to extend the life of their used furniture save costs and resources by changing upholstery or other modifications instead of purchasing new furniture.
4) Social benefits for organizations who are recipients of donated furniture, since they can improve the physical conditions of their working spaces without using their limited financial resources. This also avoids potential landfilling or incineration of furniture.

> "The other part is of course people who buy the used furniture, and I think for a lot of those they are smaller companies who don't have a lot of money so it's cheaper for them to buy used, because is normally half price or less, compared to a new furniture. And the quality is just as nice."
> Heidi Simone Kristensen, Industrial PhD at Holmgris B8 Circular"

Main Barriers:

Collecting furniture presents difficulties, particularly when this is very diverse. The more homogenous the furniture is collected, the

easier it is to manage it. Furthermore, limited warehousing capability presents a barrier, which in addition to their objective of minimize unnecessary transportation of used furniture, pushes HOLMRIS B8 circular to find a suitable purchaser of the refurbished furniture as soon as possible.

In terms of dealing with pre-owned furniture, the lack of information on the components (e.g. wood) of tables makes it difficult to meet strict standards from some markets, for example, public tenders. Since some requirements require a complete disclosure of all elements in the furniture, a task that in some cases is impossible for re-used furniture. Lastly, trends in design also increase difficulty for refurbishment, for example, color of the wood or size of desks has changed considerably in recent years.

Case: Sajkla

Country: Sweden

Description: Sajkla is a company focused in creating a stop-stop shop for reconditioned furniture. They do so by providing multiple services, like consultancy, retail space, education programs, storage and transportation. They also facilitate the interaction between users interested in refurbishing furniture and potential suppliers.

Main strategy: Eco-sufficiency, market creation and take-back.

Figure 11: refurbishing process of a chair. Photo provided by Sajkla

Circularity of business model:

Sajkla slows down material flows by facilitating the life-extension of furniture. They follow various strategies. For example, they encourage their customers to reduced their consumption of new furniture and instead based on inventory analysis, advise them in regards to the potential of their furniture to be refurbished. In some cases, they can acquire furniture directly from users, refurbish it and re-sell it through their website.

Furthermore, through their digital market, they connect users interested in refurbishing their furniture with their network of suppliers capable of conducting high quality renovation works. They allow users to upload pictures and information of their furniture and return them a quote from their network of suppliers. Their website also functions as a retail center for refurbished furniture where customer can purchase from a pre-defined selection.

Other benefits:

Sajkla is located in a small region of Sweden, with a long tradition of furniture handcraft, where multiple furniture suppliers, capable of conducting refurbishing work, are grouped closely. This allows them to draw from different expertise in terms of the type of furniture expected to be refurbished. Furthermore, by developing the remanufacturing market alongside with original producers, it also allows them (the suppliers) to understand how to design new furniture that is easily refurbished in the future.

"When we see an old chair we think: *how can we make this look current, contemporary and nice again*? Because If you can make something look *right* for this time, then you are loading this old material with value again. A value that is even greater than the one from a new new chair. Because everyone wants to do something for the environment". Jenny Ekman, Co-owner of Sajkla

By facilitating and developing the market of refurbished furniture, they benefit both potential buyers of refurbished furniture but also current users of furniture interested in refurbishing and not purchasing new. Furthermore, this incentivizes a segment of the industry (re-manufacturing) which is characterized by labour intensive activities, compared to the production of new furniture.

Main Barriers:

The public sector focuses on specific labels for furniture (e.g. Möbelfakta in Sweden) granted based on quality, environmental and social aspects. However, this standard automatically excludes the potential of purchasing refurbished furniture because of the impossibility to track down all the materials included in the old piece

of furniture. Not only that, it also makes it impossible for the public sector to also refurbish their own furniture.

Besides regulations, there are cultural barriers for the use of refurbished furniture, for example, some people might still associate them with old furniture. Lastly, there is limited information and marketplaces specialized in refurbished furniture

iv. ICT Equipment

Electric and Electronic Equipment (EEE) is a broad category that includes anything with a plug, battery or electronic cord. EEE has multiple subgroups, such as temperature-exchanging machines, lamps, white goods etc. In the context of this report, the focus is on equipment related to information and communication technologies (ICT). Products in this subgroup include most of consumer ICT equipment that can be found in average offices and households, including mobile phones, desk computers and peripherals (e.g. mouse, keyboard, memory sticks, etc.), laptops, printers, photocopiers, modems, screens, mobile phones amongst others.

Waste derived from Electric and Electronic Equipment (WEEE) is the fastest growing waste stream in the world and only about 20% of it is collected and recycled under appropriate conditions; the remaining 80% is either dumped, landfilled or treated in substandard conditions (Meloni, Souchet, and Sturges 2018). From this waste stream -estimated to have reached 50 million tons in 2018- about half of it are personal devices, such as computers screens, smartphones and tables. This particular kind of waste stream is not voluminous, yet it can be highly toxic due to the multiple hazardous chemicals and metals included in it. At the same time, these same materials, which are often limited in nature, make it one of the most valuable waste streams: it is estimated that 8% of gold, worldwide, is contained in wasted electronics (Bel et al. 2019). Value in the materials and components that make of ICT equipment can, in some cases, be more than €300 (Meloni, Souchet, and Sturges 2018).

A CE perspective highlights that the largest residual value resides not in recovered materials and components (e.g. screens, batteries) but as a full functional product (e.g. mobile phone). This product value is partly determined by the functional state of the product but also on the user's perception of it. This perception of value can be a complex assessment considering there are multiple factors, besides proper functionality, that determine if a user perceives a mobile phone as valuable (Wilson et al. 2017). Another problem with keeping ICT equipment at its highest value is that ICT equipment in particular is susceptible to "hibernation" which describes the state of unused products, stored at households, which have the potential of being refurbished and have a second-life, but remain inaccessible for organizations capable of treating them (Bel et al. 2019).

Therefore, in order to keep the WEEE stream from growing, it is necessary to preserve the value of ICT equipment, in its highest potential (as full products) in the economy. While re-use statics are unclear, some types of products, for example modems and printing cartridges, are successfully collected and re-used based on circular business models in which the manufacturer retains ownership and responsibility for the product (Meloni, Souchet, and Sturges 2018). Yet, for other consumer ICT equipment there is multiple barriers that prevent their widespread re-use; including, unfriendly design towards repair; regulatory barriers; market inefficiencies; unwillingness of consumers to accept 2nd hand products and difficulties to access acquire unused, yet functional, products that could feed into the 2nd hand market (Meloni, Souchet, and Sturges 2018).

In this section, the business models presented deal with prolonging the use of ICT equipment, avoiding its premature disposal and guaranteeing a responsible end-of-life treatment.

Code	Main Activities	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling
ICT Equipment														
F10	Refurbish / Retail	Purchase of used mobile phones, refurbish and retail on their website								X	X			
D9		Purchase of (organizations) used ICT equipment, refurbishment and retail								X	X			
D16		Refurbishment of (coorporate) ICT equipment								X	X			
F3	Service provider / refurbish / retail	ICT equipment rental, leasing or purchasing. Maintenance service provided						X	X	X	X			
N9		Manager of ICT-equipment for organizations. Services focused on leasing equipment through contracts with users.						X	X	X	X			
S3	Financing / Service provider / refurbish /retail	2nd hand ICT purchasing, upgrade and retail						X	X	X	X			
F1		Full ICT asset manager including, financing, service and maintenance, renewal and leasing/retail of used ICT equipment						X	X	X	X			
N3	Recycling	Mobile phone collector in developing markets										X		

Table 6: Cases analysed in the category group of ICT equipment

Purchase, re-sell and more

Purchasing used ICT equipment in order to refurbish and resell it is a common business model in this product category, however there are nuances that differentiate between cases.

- **D9** specializes in purchasing used ICT equipment from organizations, refurbing it and then selling it through their website. They refurbish these products, a process that includes data cleansing, parts replacement and software upgrade –the latter taking place under an official license from the software provider. They rely on their own grading system of re-used products in order to help their customer understand the quality level of the re-used product. Most of the products they sell are laptops and desktops computers; however, they also deal with peripherals (e.g. screens and keyboards) and specialized components (e.g. power supplies, memory cards).
- The business model of **F10** is similar, since they also purchase used ICT equipment, refurbish it, help customers with their own grading system and resell it through their online platform; nevertheless, they deal only with mobile phones and not a broad range of consumer ICT equipment. Secondly, they accept equipment from private users; they do so through a reverse logistics system that facilitates collection and delivery.
- For their part, **D16** displays some unique characteristics**.** Firstly**,** their focus is dealing with professional and not consumers ICT equipment. They specialize in guaranteeing certified data wiping and responsible handling of equipment once it reaches a point beyond recovery. Professional ICT equipment is a different market; for this type of customers, access to spare parts, such as mother board or other specialized components it's important, therefore, they also offer a hardware management agreement with guarantees their customers supply of spare parts. This is particularly useful for products and components that are no longer produced by major manufacturers.

Renting and leasing

Some companies keep a close collaboration with their customers through agreements which allows them to keep track of their customers' needs and provide additional services to them; For example **F3**, not only do they sell products, they offer services such as conducting need's assessments or provide maintenance service. This close interaction also allows companies like F3 to lease or rent their used equipment and collect it after the contract ends. In fact, some companies like **S3** offer flexible rent schemes, in which throughout a contract period, for example, 3 years, the company guarantees to their customers they will have functioning

Renting and leasing can be options that some companies offer, however in some cases; enterprises only operate under this model. This is the operational logic of **N9**, an organization focused on responsible ICT equipment management, particularly computers and laptops.

Value from waste

A different CBM in this category group is related to the capturing of potential value in the form of materials or components from waste streams. This is the bedrock of the model of **N3**, which offers a "material off-setting service" to their customers. This means that, for a small fee, they will collect and guarantee the proper recycling of a second-hand mobile phone in Africa on behalf of their customers

in Europe. In this way, customers in Europe can enhance their environmental performance by supporting circularity actions in developing countries.

Life-cycle-management

F1 offers a holistic approach of ICT equipment management for organizations. Their services allow their customers to acquire, manage and refresh new ICT equipment; in addition to also guarantee that, their used ICT equipment will be refurbished and re-used through leasing contracts. These services are facilitated largely through their multiple digital solutions that allow a close monitoring of all their equipment.

The business model begins with F1 facilitating the financing for acquisition and renewal of ICT for their customers. After their leasing period expiries, F1 collects this equipment, refurbishes it and re-sells it. They also collect used ICT from external users. If used ICT equipment is unable to be given a "next life", it is harvested for valuable spare parts and eventually sent to recycling. Their geographical scope of activities is transnational; consequently, they collaborate with local and national organizations for refurbishing, re-selling, part harvesting and recycling.

Case: Inrego

Figure 12: View of the testing and data erasing line at Inrego. Image provided by Inrego

Country: Sweden

Description: The business model of Inrego consists in purchasing used ICT equipment such as laptops, desktops, screens, mobile phones, network equipment, server printers etc. Afterwards, they refurbish it, clearing all the data it contains and re-selling it, leasing it or renting it to new customers.

Main strategy: Product-Service System, Product life extension, Take-back and cascading.

Circularity of business model:

Inrego slows down material flows by purchasing ICT equipment from users that consider them as waste or no longer useful. Once they acquired this equipment, they prevent its disposal by refurbish it and keep it in the economy at a high-value level.

This business model also slows down the flow of ICT equipment through the economy, by leasing and renting equipment to their customers, which allows the company to have control of their equipment and guarantee its proper maintenance. Furthermore, they can target different markets (in level of quality expected) which reduces the chances extracting the most value from products before they are disposed.

Other benefits:

Inrego provides customers that are interested in a non-new ICT equipment an opportunity to acquire this type of products, either as a sale or a rental or leasing agreement. This prevents the demand for new equipment, and hence, extraction of virgin raw materials for their production. Furthermore, by purchasing used equipment, it provides an opportunity for organizations to responsibly disposed their used equipment.

"We have been able to win a few tenders with progressive municipalities that have put in the effort on tender design in order to give refurbished ICT equipment a chance to compete". Erik Pettersson, Environmental Manager/ Circular Innovation on Inrego

They can also collaborate with manufacturers and make synergy contracts in which Inrego can guarantee a buy back of a certain amount of equipment after a period of time. This provides certainty to the manufacturers of an expected return value after three years which they can use to provide a lower price offer to their potential customer.

Main Barriers:

One of the barriers they face is that organizations (which are their suppliers of used ICT equipment) do not have the proper systems or resources in place to collect, store and sell their used ICT equipment to companies like Inrego. Furthermore, some organizations still show a resistance to service (rental/leasing) agreements, based on biased (short term) notion of purchasing being a better option.

Participating in public tenders can also be challenge. Some of the barriers include misconception from municipalities about not being able to purchase non-new ICT equipment; additionally, some

specifications put in the tender can only be met by new equipment, essentially blocking refurbished ICT suppliers. Furthermore, even when re-used framework contracts may be assigned, Inrego has experienced that users inside the municipality might not be aware or them or lack incentives for requesting refurbished ICT equipment.

Case: Recover-E

Country: Netherlands

Description: Recover-E is foundation that offers a program focused on recovering, reusing and recycling old used ICT equipment. They acquire equipment from an organization and guarantee their re-use and eventual recycling, all the while tracking and monitoring their physical and financial value.

Main strategy: Product-Service System, Product life extension, Take-back and cascading.

Figure 13: Official logo of recover-e

Circularity of business model:

The business model of Recover-E is able to slow the flow of ICT equipment, preventing its premature disposal as well as guaranteeing its control (close flow) once it has reached a stage where is no longer valuable and guarantee its recycling. Their operations rests in two pillars:

1) They enter into collaborations with their customers through medium term contracts (4-5 years) in which they guarantees that their used (and depreciated) ICT equipment will be responsibly re-used in the future. The contract collaboration includes labeling and tracking of equipment across their life-cycle; data wipe and refurbishment after collection and preparation for recycling of obsolete equipment.

2) Once the used ICT equipment has been acquired by Recover-E, they offer it through their web shop to other customers through leasing contracts. This 2-year lease includes service and replacement in case of malfunctioning while the contract is valid. After the expiration of the contract, the user is free to send it back and get a refund of €50 or keep it, only without the guarantee service. In this way, they can guarantee that their original consumers ICT equipment is used and kept in best state as possible, and not treated as waste in unknown conditions.

"Our goal is to maximize re-use of ICT equipment, not profit…we guarantee to our partners a responsible destination of their products…We aim for re-use and eventually, recycling with our established partners in Western Europe and do not export products to markets where are unable to monitor our equipment". Jan-Paul Kimmel
/ Team member at Recover-E

Other benefits:

Recover-E can be considered as an ICT-equipment broker and it is from this position that they can carry on their activities without facing some of the largest structural barriers that other actors in the supply chain face. For example, manufacturers may be reluctant to promoting re-use of equipment due to the risk of cannibalizing their own sales. Conversely, waste managers, are not allowed, per regulation, to pursue a second life for any used ICT equipment they acquire.

Main Barriers:

Compared to other ICT brokers constituted as for-profit which are ruled by market dynamics (supply and demand), Recover-E cannot guarantee a maximum commercial value in return to the used-ICT equipment to organizations. Their value offering resides on maximizing re-use, therefore, if cost is the only consideration, they are unable to compete in some cases with traditional ICT equipment brokers.

V. Clothing and Textiles

The textiles industry is involved in the sourcing and production of natural and synthetic fibers, including the various sub processes like spinning, weaving and dying. This industry requires inputs from petroleum and chemical industry, particularly for yarn production and fabric processing and relies on global logistics, since the supply chain of textiles has spread across the globe (Fontell and Heikkilä 2017). The main use of textiles is as raw material in clothing and apparel, which is in charge of the fashion industry (ibid).

Textiles, however, are not only used in clothing, they also make up rugs, covers, curtains and some are considered as "technical textiles" which may include: specialized clothing like health and safety equipment, construction components (i.e. insulation panels); or remediation and pollution control (i.e. chemical spills). These have functionality, and not aesthetic design, as their main feature (Franco 2017).

Worldwide, the textiles and fashion industry are on the rise. In the last 15 years, clothing production has doubled and since 1996 the volume of clothing purchased per capita has increased by 40% (Hemkhaus et al. 2019). This indicates that clothing demand is not only increasing due to population increase, individual consumption has also increased. Consequently, an increase in the significant environmental impacts related to the textiles industry has followed (Fontell and Heikkilä 2017). The industries' main impacts are associated with water use, greenhouse gas emissions and chemical use and discharge (WRAP 2017), and lately, due to an exponential growth of the use of synthetic fibers, release of micro plastics to the environment (ten Wolde and Korneeva 2019).

From a material flow perspective, it is estimated that 80% of clothes end up incinerated or landfilled; 12% is cascaded for other uses and only 2% is recycled and reintroduced into the production process as secondary raw materials; the rest is lost as leakages at multiple stages of the supply chain (Hemkhaus et al. 2019). This highlights the need to increase the circularity of the textiles industry, with multiple areas of improvement including collection, re-use and recycling.

Trending towards circularity?

Despite industry efforts to reduce environmental impact of their activities (e.g. development of sustainable fibers, low-impact technologies used in production of garments), the exponential increase in consumption of textiles offsets these environmental gains (WRAP 2017). In other words, minimizing the environmental impact of the textile industry cannot be a based on a manufacturing process fix, but instead requires the involvement of designers, retailers, customers, and those involved in re-use and recycling activities (WRAP 2017). Recently industry associations have recognized the need for further action closely aligned with circularity principles, including setting targets for product design for cyclability, garment collection and re-sell and use of recycled post-consumer fibers (Global Fashion Agenda 2018).

Code	Value Chain position	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling
Textiles and Fashion														

F7	Design/Retail (clothing fashion)	Artisanal manufacture of bags from leftover materials from various industries. The products transparency DNA code allows tracing materials and labour.	X				X						
F4	Design, Retail (indoor textiles)	Indoors textiles company with organic and fully recycled products made from collected bed-sheets and jeans	X				X			X		X		
R6 L2	Retail (clothing fashion)	Second-hand charity shop								X	X			
S2	Retail/Service provider (corporate textiles)	pay-per-use clothing	X					X						
N10	Manufacture and retail (corporate clothing)	Clothing design and management	X				X			X				X
N6	Manufacturer/Chain Manager (corporate clothing)	Design, manufacture and function as a "chain manager" between stakeholders in the textiles industry by providing a tracking and tracing system for clothing	X				X			X				X
D14	Manufacturer/Retail	Buy-back, rental agreements on leather jackets. Also upcycling of old jackets and parts harvesting	X				X	X	X	X				
F2	Manufacturer/Recycler (technical textiles)	Using a mechanical recycling process, the company transforms the textile materials back into fibres and uses these to manufacture new materials and products for various uses					X							X

Table 7: Cases analysed in the category group of textiles and fashion

Recycling (and its limitations)

The two main fibers used in the industry are polyester and cotton, with the polyester surpassing and almost doubling in use compared to cotton, since 2005. Recycling of textiles can take place in an open or closed loop, depending on where the recycled material is used; namely, inside the fashion

industry or in parallel sectors (Hemkhaus et al. 2019). However, the used of secondary raw materials has some critical limitations.

Recycling of polyester is achieved through chemical processes, however it is mostly limited to mono-fiber garments, which today are not the predominant in the market; consequently, recycled synthetic fibers are mostly originated from other waste streams such as PET bottles. However, this brings its own complications due to content of hazardous chemicals. Additionally, technologies for production of secondary synthetic materials require large capital investment that places recycled fibers and virgin ones at the same price level.

In turn, cotton is mostly recycled through mechanical processing which damages the quality of the material. This leads to most natural fibers (70%) not being recycled for clothing production but rather down-cycled as components in insulation, industrial cleaning cloths etc. (Hemkhaus et al. 2019). Such is the case of **F2** that uses a mechanical process that transforms surplus materials from the Northern European textile industry into fibres that are used then to manufacture, in Finland, new products for various uses related to industrial maintenance, environmental clean-ups amongst others.

Design and material choice

The largest ecological impact of textiles takes place at the sourcing and manufacturing of fabrics (Sandin and Peters 2018). Not surprisingly, several business models emphasize material selection as a way towards reducing their ecological footprint. For example**, F7** circularity is closely related to the design of their products and the choice of materials. They base mostly their manufacturing process on secondary raw materials such as regional recycled leather, salmon skin, cut-offs from the furniture industry, amongst others. Additionally, they manufacture in an artisanal manner at a workshop in Italy. This allows them to track every component of their products, including the person who worked with them, providing what they call a "Transparency DNA".

Similarly**, F4** circularity is also focused on design and material selection. Their design facilitates the recycling stage since 90% of their products are mono-material- made exclusively from cotton. Furthermore, they emphasize using organic, fair-trade cotton and linen or recycled fibers-both natural and synthetic. Besides material selection, they also are involved in take-back of their own products and collection campaigns for jeans, which they are sent for recycling with a partner company and used for producing unique products with almost 100% recycled material.

For a different market -corporate fashion- **N10** uses a similar strategy, focusing on use of recycled fibers (natural and synthetic) in the production of the corporate garments. Furthermore, they collect directly from their customer' old clothing and send them to recycling partners; which then form part of their supply of recycled fabrics to manufacture new clothing.

Local and regional re-use

Overall, across the EU, collection and re-sell of clothing is increasing -which is encouraging since it has the potential to have a positive environmental effect[3]. Regardless, second-hand clothings remains a marginal share of the total purchasing of clothing –around 9%- even in countries like Denmark which have one of the highest collection rates of textiles (44%) and where second-hand shopping is socially accepted (European Environment Agency 2018).

[3] as long as a) it substitutes purchasing of new clothing; b) the use-life is similar to that of new clothing and c) the system is not powered by fossil fuels (Sandin and Peters 2018).

However, cases such as **L2** and **R6** display a strategy aimed precisely addresses this issue. Their operational model is focused on collection of clothing from consumers, once they reach a point where clothes are no longer useful for them. This generates avoids functional clothing to be unnecessarily disposed or incinerated and at the same, once this clothing is collected, these organizations can carry on economic activities like repair and re-sell or direct donation.

These organizations both have an organizational structure as a non-profit. Operationally, both cases display a wide collection network (one across Latvia and the other across St. Petersburg respectively) which facilitates the donation of clothing articles by citizens. Furthermore, they both sort manually the incoming clothing to identify what is suitable for donation, repair or re-sell.

They both have their own selling points, but also part of the stream is directly donated to partner organizations. Furthermore, as non-for profits, the revenue generated from sales, after covering operational costs, is donated to other charity organizations with different goals. Overall, organizations like these to nurture practices like local donation, household repair and maintenance.

It is important to emphasize the importance of local or regional donation schemes compared to transnational export of used textiles. Exporting used textiles into developing markets brings some economic activity to the importing region and deals with the "waste problem" at the exporting countries; however, it also hinders local textile industry in the importing regions and creates environmental problems; especially when the infrastructure is not adequate to manage the clothing that ends up as waste. Due to these conditions, countries in the east African community (traditional recipients of collected textiles from Western Europe) have essentially banned imports of used-textiles starting on 2019 (Fontell and Heikkilä 2017).

Pay-per-use textiles

Product service systems is one of the most closely business models associated with the CE. In the textiles industry, **S2** presents the perfect case of applying this model in a Business-to-Business context. They provide access of work wear clothing for multiple industries (i.e. hospitality, healthcare) through a rental scheme. Additionally, they outsource cleaning and maintenance services for their own clothing and other indoor textiles, such as mats, mops and linens. This operations hold significant environmental value, since cleaning and drying are a stage in which the carbon footprint of textiles can be significantly reduced (WRAP 2017).

Take-back schemes and other incentives

In order to reduce the 80% of clothes that end up incinerated or landfilled, increasing collection capacity is crucial. This involves both infrastructure from waste management sector (i.e. improve collection and sorting) but also new business models from retailers which incentivize take-back of garments (Hemkhaus et al. 2019). For example, **D9** operates a business model of mostly leather jackets in which they offer a buy-back guarantee that is paid as 50% discount in the purchase of a new jacket. In this way, D9 makes sure that they can take advantage of the large residual value that used leather jackets have, since this type of product (and material) can be repaired re-used in new models with ease.

On a different strategy, **N10** performs a function of "chain manager" whose role is to track and trace clothing products across their lifetime. This facilitates their collection and the knowledge of the specific fabrics which they are composed off, both being crucial elements for a more efficient recycling.

Case: Better World Fashion

Country: Denmark

Description: Better World Fashion manufactures leather goods such as jackets, bags, oven mittens, computer bags etc. based on recycled leather. All their leather jackets include a buy-back guarantee when purchased. Additionally, they have short-term rental (4 months) and leasing model (24 months) for their jackets.

Main strategy: Product-Service System, Product life extension, Take-back.

Figure 14: Recovered leather being re-worked into a new product. Image provided by Better World Fashion

Circularity of business model:

Better World Fashion is able to narrow the material flow of by relying almost entirely on pre-owned or recycled leather to produce a broad range of leather-based products. Furthermore, they slow down the flow of leather through the economy keeping ownership of their jackets through their rental and leasing systems, which allows them to retain their products at the maximum potential value in the economy.

They also help closing resource loops by purchasing old leather garments from NGOs and other users. In addition, the buy-back guarantee, that all of their jackets include. Incentivizes their customers to return their products once they are no longer considered useful for them. This allows Better World Fashion to re-use the leather in other products.

Other benefits:

"The world needs something new. Not new things, but new ideas. Better World Fashion is a new idea. We are revolutionizing the way we produce, sell and own clothing." -first paragraph of the Better World Fashion Manifesto available at their website (own translation).

Their business model provides benefits to multiple stakeholders. Firstly, they help satisfy the demand for leather jackets without increasing demand of virgin materials that in itself, brings about an environmental benefit. For their environmentally conscious customers, they are able to access leather jackets that have a significantly lower environmental impact. Additionally, their financial models allow new customers to try a luxurious article such as a leather jacket without the large financial investment required.

Furthermore, they provide an income stream for NGOs that are focused on collecting used garments, similarly to users with un-used leather products at home.

Main Barriers:

The main barriers or disadvantages that Better World Fashion faces is difficulty in competing with the price level that their competitors are able to offer. They understand the traditional modus operandi of the fashion industry is based on environmental and social exploitation that allows bringing down prices. Therefore, the decision to improve their production processes in terms of environmental and social protection makes them more expensive to produce.

vi. Miscellaneous

This section includes business models that were hard to precise to a category group or there were not enough similar cases to provide a general overview of the industry. Nevertheless, they provide an example of the broad scope in which circularity can be used as a business model.

Code	Main activity	Brief description	Circularity Strategy											
			Design			Production		Use				Recovery		
			Circular Product Design	Eco-sufficiency	Market creation	Industrial symbiosis	Secondary Raw materials	PSS	Product-life extension	Take back	Cascading	Parts Harvesting	Biological Recovery	Recycling
Miscellaneous														
R8	Remanufacturer	Extending the life of ships and vessels through a variety of maintenance and service interventions							X	X		X		
L1	Service provider	Company offering a holistic "pay-per-drive" model to users, facilitated by a mobile application which tracks automobile booking, registration and use						X						
R3	Online Market	Online platform for consumer-to-consumer interactions, focused on rental of consumer products			X									
P6	Recycler	Innovative end-of-life treatment of tires which is able to generate three valuable by-products and avoid incineration or landfill												X

Table 8: Cases analysed that were considered as miscellaneous and not fitting in the previous category groups

Starting with **R3**, an online market that facilitates rental transactions amongst citizens in the large cities in Russia (e.g. Moscow, St. Petersburg). They offer a platform that allows users to become renters or to rent various consumer articles such as clothing, sports equipment, power tools etc. The site automatizes the rental process and the management team function as a mediator to help resolve disputes. This type of digital markets make renting easier (improving market efficiency) which can lead to more intensive use of durable products. Intensifying the use of products can bring environmental benefits if the rented products substitute the purchase of new ones, however, if they simply increase consumption which was previously inaccessible, it might be resulting in a rebound effect (Zink and Geyer 2017).

Also related to intensifying the use of a durable product, **L1** offers short-term car-rental service (Business-to-consumer) in Latvia. The company serves both individual and corporate consumers; with the latter being able to enter in a contract agreement. L1 business model is based on providing users to access to drive any of the available automobiles of the company's fleet. Users, after registration, pay a single fee that covers all costs including fuel, insurance, maintenance and parking. L1 facilitates

the rental process through their own mobile application that monitors and tracks the use of their automobiles.

From a CE perspective, recycling is considered, as a last resort option only after prolonging the use of products is no longer possible. However, in some cases, there is no other solution. Therefore, business models like **P6** provide a valuable contribution by handling end-of-life tires through their technology of continuous pyrolysis. This recycling strategy allows them to produce three by-products: gas, oil for rubber production and carbon black. Through this process, P6 is able to recover valuable raw materials which otherwise would be lost through traditional end-of-life treatments such as incineration or landfill.

Case: Ship technical service Ltd., Novorossiysk

Figure 15: Recovered ship being repaired. Image provided by Novorossiysk.

Country: Russia

Description: Novorossiysk is a project-based company specialized on extending the life of ships and vessels through a variety of maintenance and service interventions. They have competences with dry cargo ships, tankers, ferries, tugs, floating cranes, barges, catamarans, yachts, pontoons and passenger ships.

Main strategy: Product-life extension, Take-back, parts harvesting

Circularity of business model:

Novorossiysk slows down the flow of ships and vessels in the economy by means of multiple service interventions such as 1) maintanance and repair of main and auxiliary engines, diesel engines, generators, electrical equipment or 2) refurbishment of ships and vessels by replacing of worn-out components with parts newly purchased or manufactured in-house. Including full restoration of ship hulls.

They also close material loops by purchasing wasted ships and other equipment and restoring them to a functional state. Then, this equipment is either used in-house in the companies' operations or re-sold to customers. Furthermore, they specialized in part harvesting from ships and vessels before being disposed as metal scrap.

"Traditional approaches are used by large enterprises such as car factories, shipbuilding and aircraft factories, the purpose of which is the creation of new machines. Our job is to repair equipment that has been used for a long time, and restore its performance. It happens: some build, others repair." Vladimir Vinogradov / Deputy Director at Novorossiysk

Other benefits:

Their capacities to repair and refurbish old wrecked ships allowed Novorossiysk to build up their own fleet of boats that diversify their potential business activities (i.e. water transport, transport specialists, crewmembers etc.). Overall, their fleet helps their business become more sustainable during periods of decline in ship repair orders.

Furthermore, working with multiple types of wrecked ships, vessels and equipment has developed Novorossiysk into an agile company which is capable to adapt and work with different equipment, even outside of the shipping industry, for example special equipment in the construction of wind farms. Traditional manufacturers are bounded to their specific trade, for example making new ships. This agility has also helped them develop a positive reputation in a context where burocracy and red tape characterizes business transactions.

Main barriers:

As expected for project-based business models, it is a challenge to secure constant orders and contracts. However, this barrier has been partially addressed by expanding their business activities into other economic activities, facilitated by the ship and vessel fleet they have developed.

IV. Conclusions

The objective of the research was to provide an overview of the alternative business models currently available in the Baltic-sea region market suitable for a circular economy and recommend alternative business models and partnerships suitable for public procurement. In the following section, a brief overview of each category group is provided followed by recommendations related to the role of public procurement can have in order to promote the development and make the most of on the strengths from the available CBM.

Food and food-based products

Based on the enterprises analysed in this category group, it was possible to identify multiple CBM that are viable in the current context. These can be arranged in three major groups:

- Circulation of secondary and waste flows amongst different actors in the supply chain. This not only reduces the amount of waste food, but it represents the foundation of CBM which are able to capitalize on the residual value of these flows and use them as secondary raw materials.
- The creation of secondary markets at the retail and food service level. This approach of CBM is based on enhancing (or if necessary, creating) a market place, either digital or physical, in which different actors (suppliers and consumers) can trade on secondary or waste flows since the main distribution channels (wholesalers, retailers, restaurants) deal mostly on class I produce.
- Modifying consumer practices. This last group is important since it bridges supplier's actions with consumer practices. Particularly in the context of the EU, where consumers at the household level are the number one source of food waste, CBM that engage directly with influencing consumer behaviour, for example by allowing consumers to buy in bulk, or providing information on waste-minimization techniques, are greatly required

Based on data collected in this research, the following considerations can be taken by public procurement departments in order to promote and make the most out of the strengths from the available CBM:

- Consider the amount of packaging used in the supply of catering or canteen services and push towards bulk delivery, zero packaging and container take-back from suppliers. Particularly on catering events when single-serving items are mostly used
- Consider the amount of wasted food generated, either from catering events or daily canteen activities and engage with organizations that are willing to rescue and redistribute the leftovers.
- Consider accentuating cooking and conservation techniques that reduce the generation of food waste at the preparation stage
- Consider the separation of organic and inorganic waste.
- Consider treating organic waste in a way in which nutrients are recovered or in case is not possible, energy is recovered.
- Consider allowing internal clients (users of canteen and catering services) to decide on portions and engage them with food-waste prevention campaigns.

Built Environment

Overall, the built environment is a very diverse sector and it would be difficult to provide a full overview of all the circularity activities taken place in it. However, taking the cases analysed and grouping them following the model introduced in figure 6, four main types CBM can be identified:

- Construction services: Focused on connecting construction and demolition through the creation of a market for secondary construction materials, matching demolition waste with construction sites in the same region. Furthermore, actual construction project development with designs based on available materials, including wasted materials available in the region and site.
- Construction supply: enterprises in this sector focused on supplying specialized components including carpeting, luminaries and insulation panels. These CBM highlight that circularity at a facility level is influenced directly by the circularity at each of its components. Furthermore, from an operation management perspective, two product-service systems arrangements were identified, offering lighting and signage as a service.
- Renovation: Two CBM where identified particularly in renovation of lighting fixtures. These highlight, that existing infrastructures can also be suited for circularity interventions.
- Demolition and Recovery: two cases addressed circularity at the end of life of infrastructures. One, recovering bricks from demolition of houses and buildings and the other, recovering raw materials from artificial turf facilities through a specialized recycling technique.

Based on the information obtained, the following considerations can be taken in public procurement in order to promote the development and make the most of on the strengths from the available CBM:

- Consider flexible designs for new infrastructure that are open for changes based on regionally available materials.
- Consider renovation of internal components -for example lighting fixtures- before purchasing new components.
- For internal components with a medium-time life span like carpeting and panels, consider take-back options. This can be in the form of pay-per-service contracts in which the supplier retains ownership, or contract clauses that guarantee collection and re-use.
- Consider selective demolition and components recovery for contracts dealing with end-of-life infrastructure, including innovative recycling techniques that allow recovery of valuable raw materials.

Furniture

The CBM in the furniture group include cases with different scopes and market segments. Some of the cases focus on the so called “contract furniture”, which involves larger volumes in the context of hospitals, education institutions, offices and the public sector in general, whilst other focus on “private” furniture, which is design oriented, handcrafted and unique. The circularity strategies used in each sector differ; specifically contract furniture cannot depend on waste flows (since they do not provide reliability for their volume of production) but instead focus on used-product flows, particularly from organizations.

Some cases focus on single aspects of circularity such as a) material selection and chemical avoidance, b) incorporation of waste as raw materials or c) the development of the re-manufactured furniture market. A more holistic approach was presented with two CBM, both of which in addition to designing and manufacturing long-life and modular products, they collect and take-back furniture, which allows them prolong the use-life of furniture (i.e. refurbishment) and re-sell them after the initial customer no longer desires to use them. Furthermore, one case describes a company where full office furniture management is offered based on service contracts that cover all stages from design, (re)manufacturing, maintenance and take-back.

Based on the information obtained, the following considerations can be taken in public procurement in order to promote the development and make the most of on the strengths from the available CBM in the furniture sector:

- Consider if the needs of furniture can be satisfied by re-furbishing of existing furniture instead of purchasing new.
- Consider using recovered (waste) materials in the manufacturing of furniture, particularly for small-scale projects.
- Consider collaborating with organizations that can facilitate donation of existing furniture in case new furniture is expected to be purchased.
- Consider if it is necessary for the public organization to own the furniture or if the supplier can keep ownership of it and only guarantee functionality.
- When arranging for suppliers to take-back or buy-back furniture after a certain period of time, consider contract clauses that make sure that the furniture is not disposed but instead repaired if possible and given a second-life.
- Consider identifying functional requirement such as “working area for X amount of persons” instead of focusing on requesting specific pieces of furniture (e.g. Y amounts of desks and a Z amount of chairs).
- When purchasing new furniture consider the following:
    - Materials used in its manufacturing process particularly wood, textiles and metals
    - Dyes and adhesives used in its manufacturing
    - A modular design that can allow repair, replacement and dis-assembly of the furniture at the end-of-life period

ICT Equipment

Overall, the CBM analyzed in this category are focused on preventing the premature disposal of ICT equipment. They rely on capturing the residual value of used equipment by acquiring it or purchasing it from organizations and private individuals; then preparing it (i.e. refurbishment and data wiping) for future consumers. The companies whose market are private consumers rely on rating systems which facilitate communication of quality standards and overall increasing the efficiency of the market. Some of the cases display a close collaboration with users that allows them expand their financial schemes, from single purchasing, into rental leasing (and buy-back guarantee) all the way to full ICT equipment management for organizations.

Based on the information obtained, the following considerations can be taken in public procurement in order to promote the development and make the most of on the strengths from the available CBM in the ICT equipment sector:

- Consider an inventory and needs assessment service, this will allow setting a baseline of the current equipment which can be valuable information for upcoming tenders.
- If there is a need for ICT equipment and a tender is expected to be developed, consider functionality and needs, instead of technical specifications. This will allow refurbished equipment suppliers to participate in the process.
- Consider flexible agreements in which the supplier retains ownership of ICT equipment and guarantees their functionality throughout the contract. Consider contract-clauses related to the actions expected to be taken once the equipment is collected after the contract expires.
- Before purchasing new, consider if it is possible to refurbish current equipment.
- If refurbished equipment contracts are available, consider promoting them with the internal clients and emphasize their value, so they are more likely to be used.
- If new equipment is to be purchase, consider a take-back scheme in which the supplier, or other organization, can guarantee that the current ICT equipment will be refurbished collected, refurbished and reused, not simply recycled.
- If take-back arrangements are made, emphasize re-use (and monitoring) instead of commercial value return
- If take-back arrangements are made, consider certifications for data wiping and compliance with data privacy regulations.
- Consider collaborations with organizations that offset the material impact of new ICT equipment purchases by actions in developing markets such as collection and guaranteed recycling.
- Consider including labelling and tracking of current ICT equipment as a requirement in order to facilitate its monitoring thorough its lifetime.

Clothing and textiles

Overall, the CBM analyzed in this category covered three main aspects: design and material choice for new products, collection repair/recycle and re-sell, and clothing management. The types of organizations involved are both commercial enterprises and not-for-profit organizations, particularly involved in the collection, donation and local or regional re-sell of clothes.

For new clothing and textile products, design can be aimed at creating mono-material products. Furthermore, it can be focused on incorporating recycled content (both natural and synthetic fibers) as well as secondary raw materials originated as by-products from other industries (e.g. furniture sector) or directly collected from waste streams (e.g. old jeans).

The different business models analyzed display unique strategies for collection of textiles: from take-back arrangement of their own products, buy-back guarantees, or widespread collection points across a city or a region for consumers to deliver their un-wanted clothes. Collected garments can be donated, re-paired and resoled, re-worked into new garments, or down-cycled to manufacture new products.

One case displayed a business model in which cooperate clothing is offered as a service, as well as the outsourcing of other clothing-related activities such as washing, drying and maintenance. Lastly, one case takes a chain manager position that facilitates tracking and monitor of clothing across their lifetime.

Based on the information obtained, the following considerations can be taken in public procurement in order to promote the development and make the most of on the strengths from the available CBM in the clothing and textiles sector:

- Consider the functionality of clothing as a service instead of the direct purchase of clothing articles.
- If purchasing new clothing, consider establishing contract-clauses for buy-back guarantees or collection.
- Consider end-of-life treatment that prioritizes, repair and re-sell or donation, and leaves recycling as a last option.
- Consider material choices and design (e.g. recycled material, mono-material clothing) when purchasing new clothing
- Consider use-phase (cleaning and drying) educational campaigns or the potential of some suppliers to provide a holistic service covering these aspects.
- Consider collaboration with partners dealing with local and regional collection, repair and donation
- Consider the use of clothing managers that can facilitate keeping track of ensuring the responsible use/re-use of clothing

V. Annex

Detail of data collected from each case

Category	Cases	website	semi-structured interview	structured interview	Other sources
Food and food based products	R1	x			
	P1	x		x	
	D11	x	x		
	S6	x			
	P4	x			
	N13	x			
	F9	x			
	S4	x		x	
	S8	x	x		
	S9	x	x		
	L5	x	x		
	D7	x			
Furniture	S7	x	x		
	D6	x	x		
	N8	x			
	F8	x			
	D8	x			
	D13	x		x	
	P5	x		x	
	D15	x		x	
Built environment	N12	x	x		
	S10	x		x	
	D12	x			
	S1	x	x		
	D4	x	x		
	D5	x		x	
	D3	x			x
	N4	x			
	D10	x		x	
ICT and equipment	S3	x	x		
	F10	x			
	F3	x			
	F1	x			x
	N9	x	x		
	D9	x			
	D16	x			
	N3	x			

Textiles	N6	x		x	
	F4	x			x
	N10	x			x
	F2	x			x
	F7	x			
	D14	x			x
	L2	x			
	R6	x	x		
	S2	x			x
Other	L1	x			
	R8	x	x		
	R3	x			
	P6	x			x
Total	50	50	14	9	8

Interview guide used during the semi-structured interviews

Theme	Guiding questions
Business Model Description	Q: How would you describe your BM? Q: How is your BM different from your "linear" competitors? Q: Is there a difference in the costs you have or in revenue structures? Q: Is there a difference in the way you collaborate with suppliers/customers?
Circularity	Q: How does your BM reduces the use of materials? Q: Do you use non-virgin or wasted materials as raw materials in your production? Q: Do you repair, refurbish or remanufacture products? Q: Do you collect any products considered as waste or unwanted? Q: Do you create (or improve) markets for suppliers and costumers to interact?
Advantages and Barriers	Q: Can you mention some of barriers or disadvantages that you have faced operating this BM compared to a linear model (e.g. regulation, sourcing, market demand, etc.)?
Procurement Experience	Q: Have you participated in public tenders? Q: How can you use circularity as an advantage to win tenders?

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