

Circular economy stakeholder perspectives:

Textile collection strategies to support material circularity

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Abstract

The circular economy calls for a coordinated redesign of production and consumption patterns, ensuring that cascading material and product resource use continues for as long as possible. Moving away from the 'take, make, use and dispose' paradigm, the circular economy aims to extract the maximum value and utility from resources and products, encouraging principles such as zero-waste design, product-life extension and resource recovery, as well as repair and remanufacture services. Beyond waste reduction and recycling, a more circular textile sector needs to involve industrial, commercial and policy-making communities; spurring new forms of collaborations between and across traditionally linear value chains. Indeed, whilst technology innovation is crucial, with the search for new and improved ways to sort, separate, decontaminate and recycle textile fibres, the importance of process and business innovations must not be overlooked.

This paper looks at the Horizon 2020 funded research project Resyntex, which strives to implement a circular redesign in the textiles sector. Within Resyntex, the authors have conducted stakeholder consultations in four geographically distinct regions throughout Europe, which utilise different approaches to the collection of textile waste, sourced from consumers, industry and institutions. The consultations took place in participatory, multi-stakeholder focus groups, whereby careful attention was paid to ensuring a balanced participation, bringing in diverse viewpoints and experiences and overcoming issues around competition and commercial sensitivity. Examining textile waste routes and their corresponding mosaic of collectors, sorters and recyclers, this paper identifies the key drivers and opportunities for textile waste collectors for a transition to more circular value chains. Through stakeholder engagement, the research proposes how conditions for collectors' adoption of circular practices can be improved, while avoiding sectoral disruption and ensuring maximum effectiveness of the redesigned chain of secondary textiles.

Barriers to circular economy textile solutions are presented in the form of outdated waste legislation and under provision of commercially viable recycling technologies for low-grade textiles. Collectors are keen to focus solely on 're-wearable' textiles for reuse, neglecting streams for more costly recovery solutions. Continuous management of the transitional economic risks will therefore be imperative for textile collectors to support the circular economy, ranging from certified standards, support for R&D, access to finance, collaborative innovation mechanisms as well as guarantees on resource supply and price stability. Key drivers for promoting a wider range of recovery streams include policy incentives (such as Extended Producer Responsibility) and economic and environmental strategies such as the diversion of textiles from landfill and Energy from Waste (EfW). Network innovations and B2B partnerships can connect retailers, collectors, recyclers and end-users more closely, presenting major incentives to take circular routes and creating wider benefits for the industry as a whole.

Key words: Circular Economy, Textiles, Stakeholders, Recyclers, Collectors, Strategies



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1. Introduction and Background

The organisation of production in terms of material use has increasingly come under scrutiny (Livesey and Thompson, 2013). The 'take-make-use-dispose' linear economic model has been called into question in terms of resource efficiency and negative effects along the material chain. A key concept which has been put forward to mitigate the risks associated with this linear model is the circular economy. The Ellen MacArthur Foundation asserts that innovative business models, such as those which change from ownership to usage, service and performance based payment models, will be instrumental in translating products designed for reuse into attractive value propositions (Ellen MacArthur Foundation, 2010).

The Ellen MacArthur Foundation defines the Circular economy as: *'An industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.'* (Ellen MacArthur Foundation, 2013). The Ellen MacArthur Foundation (2014) circular economy model (**Figure 1**) shows cascading cycles of disassembly and reuse, in which short-life consumable products are largely made from biological ingredients and durable products are designed to have their technical components recycled and upgraded.

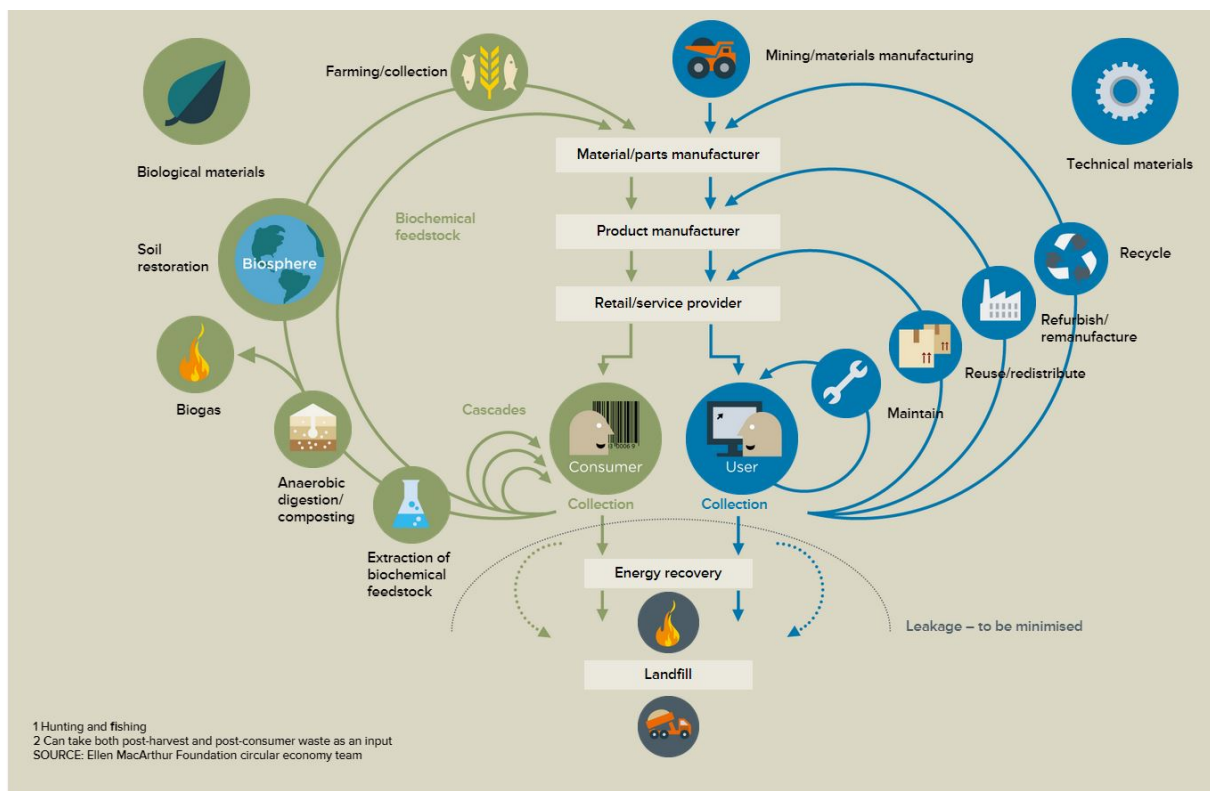


Figure 1. The Ellen MacArthur Foundation (2014) circular economy model

This concept works to link material inputs and outputs in the system with reuse as much as possible. Localised industrial clusters within this system reduce energy and transport requirements (Livesey and Thompson, 2013). The European Commission's (2011) communication 'Roadmap to a Resource Efficient Europe' outlined the Commission's vision of an EU economy with a respect for resource constraints and planetary boundaries. The aim is for all resources to be 'sustainably managed, from raw materials to energy, water, air, land and soil.' Climate change milestones have been targeted, while biodiversity and the ecosystem services it underpins should be protected, valued and substantially restored by 2050. This has been further supported by the (European Commission, 2015) 'Circular Economy Strategy', which is aimed at developing a common and coherent framework at EU level to promote the circular economy. Actions proposed to put this into practice are; defining waste and recycling targets, improving the implementation of waste legislation and tackling specific waste challenges related to significant loss of resources or environmental impacts. Key points for circular economy textiles within these proposals include banning the landfill of recyclable plastics by 2025, further promoting the development of markets for secondary raw materials and setting a resource efficiency target which would increase productivity. (Euratex, 2014).

Circular economy models work to highlight the cascading reuse options to keep existing materials in productive use for longer, for maximum lifecycle savings. Links between material flows are considered, however for a more circular textiles sector to function effectively, collaboration and communication between stakeholders at each stage of material flow and production are necessary. Perspectives and inputs from a wide breadth of stakeholders create an understanding of how process and culture changes can be implemented. Joung and Park-Poaps (2013) note how current short fashion lifecycles and low prices have led to a proliferation of unwanted garments and textiles. Farrant *et al.* (2010) stated that 'clothes are often discarded when much of their potential lifetime is left'. Woolridge *et al.* (2006) have quoted figures from the Salvation Army Trading Company Ltd that conclude that when clothing is disposed of, it still has at least 70% of its useful life left.

The majority of re-wearable superfluous textile items collected are exported for reuse, however there is still limited understanding of the true end destination of these items (Bartlett *et al.*, 2013). Once collected, post-consumer textiles are processed and sorted; an activity requiring skilled workers to identify and separate wearable textiles, and differing properties in unwearable textiles, ready for recycling. In a study by Farrant *et al.* (2010) the route of donated second hand clothing (SHC) is defined hierarchically, with the best pieces being resold in

western markets, lower quality items exported to Eastern Europe and Sub Saharan Africa, and the least good recycled, incinerated or thrown into landfill. As little as 3% of collected textiles are re-sold in the UK, as premium or vintage clothing, which can have a re-sale value much closer to that of new clothing. Around 75% are exported for reuse overseas, with 18% sold as recycling grades (Bartlett *et al.*, 2013).

Although volumes of textiles collected for reuse and recycling have grown substantially since 2003 (Morley *et al.*, 2009; Bartlett *et al.*, 2013), a significant fraction of textiles enter into municipal waste streams from consumers and homes, and as items rejected from commercial sorting activities due to their low grade nature. Bartlett *et al.* (2013) estimated that over half of all textiles disposed of in the UK in 2010 (53%) were sent to landfill (1,386,000 tonnes), and a further 350,000 tonnes (13%) were used to produce energy from waste (EfW). Much of this was clothing and footwear from household residual waste, which could have been reused or recycled. It is estimated the value of the textiles discarded through kerbside residual waste and destined for landfill to be worth £238 - £249 million had these textiles been reused or recycled. Morley *et al.* (2009) recommend that as traditional markets in the UK are declining, development, such as innovation in new markets will help to stabilise this decline and also create new markets for textile reuse. The Resyntex Project aims to create a new circular economy concept for these low grade and discarded textiles, in which un-wearable textiles are transformed into secondary raw materials of value to industry.

2. Methodology

A case study approach was adopted for this phase of research within the Resyntex Project. A case study is a mixed methods research strategy which entails the detailed and intensive analysis of a single case to understand complex factors in a particular real world setting (Denscombe, 2010; Bryman, 2012; Yin, 2014). This approach allowed the investigation of stakeholder perspectives, including perceived barriers and opportunities for redesigning regional textile waste chains. In selecting the cases for study, each unit of analysis was defined as a geographical location. The four case study regions identified were Greater Manchester, UK (GM); Haute-Savoie, France (HS); Lower Styria, Slovenia (LS) and Northern Tuscany, Italy (NT). Research activities centred on a particular city in each region; namely Manchester, Annecy, Maribor and Prato. These activities included stakeholder mapping and desk based research to select participant stakeholders for each of the four focus group discussions which took place in each region.

Regional focus groups gathered between 15 and 20 regional stakeholders from a wealth of sectoral backgrounds, representing diverse positions along the value chain and working with

different typologies of textile waste. The balance of interests and perspectives within these group discussions was preserved using the Prospex CQI-methodology (Criteria-Quota-Individuals) (Gramberger et al., 2014), as a form of purposive sampling, as well as through a careful preparation and design of the focus group process. Purposive sampling is a form of non-probability sampling in which participants are selected in a strategic way, so that those sampled are relevant to the research questions that are being posed, based on the researcher's judgement (Bryman, 2012; Dadigamuwage, 2012). In this way, researchers may decide to select participants on the basis of an explicitly stated criteria (Lindlof and Taylor, 2011). In essence, Prospex-CQI stands for:

- ✓ Criteria (C): Defining a set of criteria for stakeholder groups that are either affecting the topic of research, being affected by it, or both.
- ✓ Quota (Q): Setting specific minimum quotas for all categories.
- ✓ Individuals (I): Identifying individuals that fit the categories, with the overall selection fitting the quotas set.

For the purpose of this research, a total of six types of stakeholder selection criteria have been established, pertaining to stakeholders' position along the value chain, their organisational affiliation, the waste typology they are working with, the geographical scope of their activity as well as the gender and age of the individual stakeholder. For each focus group, sets of minimum quotas were established per stakeholder category, which underpinned the participant selection process. As a semi-structured, open ended interview technique, focus groups are suitable for situations in which asking questions with a general idea of topic and rough notion of sequence are known, but not fully specified in advance (Jankowicz, 1995). A clear idea of purpose is necessary however (Jankowicz, 1995), and from Krueger and Casey (2009), specific points about when to use focus groups have been highlighted that apply directly to this research:

- To find out the range of ideas and feelings that people have about something.
- To uncover factors that influence opinions, behaviour or motivation:
- To provide insight into complicated topics when opinions or attitudes are conditional or when the area of concern relates to multifaceted behaviour or motivation.
- For ideas to emerge from the group:
 - A group possesses the capacity to become more than the sum of its parts, to exhibit a synergy that individuals along do not possess (Krueger and Casey, 2009)

These instruments enabled a diversity of viewpoints to be expressed, while at the same time overcoming issues around competition and commercial sensitivity through the multi-stakeholder set-up. Guided by a facilitator, stakeholders were introduced to the project and its

prospects for circular redesign, and were enabled to participate in a lively, rich and natural discussion on textile waste routes and potential solutions to spur the circular transition. As a result, the focus groups generated a wealth of information and profound, first-hand insights, which would prove difficult to collect through online or quantitative means. In analysing the data emerging from the desk research and stakeholder focus groups, the qualitative research strategy employed in Grounded Theory was utilised (Glaser and Strauss, 1967), whereby explanatory ideas are sought out in the first stage and then given a descriptive, conceptual label. Concepts that emerged as closely interlinked were then clustered into categories.

3. Results and Analysis

The research sought to uncover what incentives exist to increase the reuse and recycling rates for non-wearable and low-grade textiles, and what types of barriers were felt to be impeding continuously cascading cycles for discarded textiles. In the following tables, the key themes of the research, across the four case study areas, are described.

Table 1. Barriers cited by stakeholders which impede the circular transition	Case Study Region	GM	HS	LS	NT
	Country	UK	FR	SI	IT
Lack of technological development		x	x	x	x
Added-value and commercially viable recycling options remain scarce for the low-grade textiles fraction		x	x	x	x
Low quality materials and blends dominate the end-of-life material flow		x	x	x	x
Costly recovery process		x	x	x	x
Outdated waste legislation		x		x	
Lack of traceability in the global waste chain				x	x
Poor consumer demand for recycled products		x	x	x	x

Whilst the barriers listed in **Table 1** are primarily of a technical and regulatory nature, the drivers in **Table 2** are factors which encourage a cyclical textiles supply “loop”, rather than a linear “chain”. Drivers for circularity are rich and multifaceted, stretching from the global to the local, from resource and market fluctuations to municipal governance. Stakeholders are confident that the case for the circular economy is tangible and credible, yet also vividly aware that unlocking these changes will require strong and concerted efforts to accelerate the uptake of recycling technologies and hence embrace the technical skills, plus business and process changes within and throughout the textiles and waste management communities; connecting production, use and end-of-life in a joint undertaking.

Table 2. Drivers cited by stakeholders for enhanced textile circularity	Case Study Region	GM	HS	LS	NT
	Country	UK	FR	SI	IT
Natural resource depletion (water, soil, fossil fuels)		x	x	x	x
Environmental gains		x	x	x	x
Cost-cutting opportunity for the industry		x	x	x	x
Unexploited material streams		x	x		
Growing consumer awareness		x	x		
Extended producer responsibility		x	x		x
Connectivity of material streams – cluster collaborations				x	x
Design for end-of-life		x	x	x	x
Residual waste management policy		x	x	x	x
Global paradigm shift from oil-based to bio-based materials - strengthens the business case for bio-based and recycled fibres					x

3.1 Barriers

The still largely inadequate technological capability to provide high value recycling of textile fibres was a recurring concern by stakeholders across the case study locations. The industry currently lacks mainstreamed, up-scaled processes and know-how to sort and separate singular fibre types, which are usually tightly bonded in mixed blends. Additionally, innovative approaches to the recycling and valorisation of specific fibre types, such as cotton and polyester, are still in development stages, and not yet integrated into industrial processes. As a result, the collection of low grade textiles presents an economic cost (collection, transport, sorting) that is not outweighed by the fraction that could deliver added-value through reprocessing, remanufacturing or recycling. The collection of greater volumes of textiles, which for a large part consist of non-wearable and lower-value items, will therefore need to evolve in parallel with a growing use of recycled fibres and other end-products derived from textiles. The problem of costly logistics paired with the low availability of textile recycling plants on local and regional levels creates a twofold barrier to the wider employment of circular economy textiles strategies. Discarded textiles travel widely, usually to overseas markets; the local links between potential suppliers and recyclers are still missing, as are accessible, locally established marketplaces where secondary textiles can be traded. At the same time, opportunities abound to enhance the sustainability of garments and textile products and thus

diverting them from disposal for as long as possible, by extending their lifespan, by finding new owners of the product, by the choice of materials and construction of the product, by promoting “slow fashion”, by offering a repair service for minor wear, by promoting the practice of clothes-swapping, and by mechanical pulling of the materials to recover textile fibres that can be incorporated into new products (Boiten et al., 2017).

There are also more location-dependent barriers however, inherent to the legislative, market and policy frameworks in which collectors, recyclers and waste managers operate. Concepts such as waste, end-of-life and reuse/recycling remain shrouded in legal and semantic ambiguity. Importantly, their use and interpretation remain crucially divorced from the all-encompassing, regenerative framework advanced by the circular economy. Discarded textiles currently inhabit a “no-man’s land” between what is considered “waste” and “product” (or secondary resource), complicating stakeholders’ abilities to trade, export or import excess textiles and to forge direct, market-based linkages between material streams. While the EU has defined end-of-waste criteria, declassifying waste and granting it the status of a product, textiles were not yet taken up in these end-of-waste criteria (see Villanueva et al. 2010). In the UK, post-consumer textiles and clothing discarded from households are considered as municipal solid waste (Morley et al., 2009; Dadigamuwage, 2012). The cut-offs and other cloth scraps that result from production processes do not fall within the legal scope of waste however, opening the door to misinterpretations. A similar issue was brought up in Lower Styria, where the Slovenian language employs the very same word for “waste” as for “reusable”. This poses challenges to authorities and recycling business to develop clear-cut narratives that enable consumer awareness and empowerment in the recycling of clothes.

Beyond legal and conceptual intricacies, the case study regions, with the exception of the industrial cluster of Prato, struggled with the opaque and fragmented nature of the routes travelled by discarded textiles. Indeed, “recycling actually means transferring,” as one participant in the focus groups claimed. Textiles were seldom collected, sorted and graded within the same geographical area, nor by the same commercial enterprise or public entity. In the case of Slovenia for example, the disposal of textiles occurred almost entirely in neighbouring Austria. In the absence of transparent waste chains nor a comprehensive overview of the intermediary steps and ownership transfers involved, it is almost impossible to determine or attribute responsibilities for reuse and disposal. Additionally, the lack of a coordinating mechanism deepens the intricacies of making accurate predictions on volume, quality and regularity of supply. This further points to the need to connect waste managers, collectors, sorters and recyclers in a transparent, knowledge-sharing effort that enables more clear-cut analysis of the end-of-life stage and how textile use can be extended or regenerated. While subject to disparate waste management regimes, the case study areas were affected

in largely similar ways by changes and revisions of residual waste policies, whether at the local, regional or national level. While current issues such as a lack of government driven textile collection in Slovenia and the need for greater municipal level involvement to separate material sources in Prato present initial obstacles, the potential direction for developing extended material use and reuse is also indicated by existing regional practices.

3.2 Drivers

Stakeholders readily identified a wide range of opportunities offered by the circular economy, such as the environmental benefits of enhanced resource productivity, but also the cost savings presented by more widespread recovery and reuse. At present the duties and fees on landfill, incineration or other disposal options constitute an immediate cost burden which all stakeholder groups are very reluctant and in some cases unwilling to bear. There are however other developments, beyond immediate cost savings, that strengthen the viability prospects for enhanced textile circularity. These include a growing awareness among consumers of the human and ecological burden of the textile industry. Moreover, stakeholders in all regions agreed that textile waste streams remained crucially underexploited, as opposed to other material streams such as tyres and batteries.

Across the case studies, the stream of professional clothing was singled out as a prime testing ground to provide proof of concept for closed material loops. This uncharted territory, consisting of workwear, bedlinen, medical textiles and uniforms, offers volumes that are large and consistent in supply, whilst at the same time with clear insight into the material composition and the general state of the textiles, compared to residual waste or garments donated by consumers. However, each region faced various security issues connected to the handling of corporate-wear textiles. In the UK, where branded corporate-wear could lead to misidentification of wearers, companies often require a certificate of destruction if clothing is to be donated. This often results in shredding of the garments, thereby limiting recovery options. (Bartlett et al., 2012). Also in the UK, NHS-staff members are largely individually responsible for the maintenance, laundering and disposal of their workwear (Riley, 2015). In Anancy, similar issues of ownership were highlighted. For example, army uniforms are officially owned by the individual, which explains the lack of an overarching structure for the collection of these pieces.

A further driver for the adoption of recycling and remanufacturing initiatives lies in the establishment of Extended Producer Responsibility (EPR) schemes, such as the Eco-TLC programme pioneered in France since 2008. French legislation obliges producers, importers and retailers of clothes, linen and footwear to manage the end-of-life stage of their products,

hence extending the producer responsibility for textiles. In order to manage the recycling of their products, companies can sign up to the government-accredited scheme Eco-TLC, run by a private organisation. This system however does not currently include workwear and professional clothing. Integrating this stream into EPR was felt to be a potential flagship demonstration of closed textile loops. Stakeholders in Prato also discussed how EPR-experiments in the textiles sector were gaining traction. Since the end of 2016, textile waste is officially considered a “special category” of waste by the local authorities, obliging each party or company generating textile waste to divert its textiles from residual waste streams by entering into a contractual collaboration with certified recycling companies.

Further opportunities lie in the proximity and connectivity of “input” and “output” material streams, in particular in the case study region of Prato which stands out for its great number of textile factories and suppliers servicing the entire textile industry. This region represents a modern industrial cluster, and can also look back on century-old traditions in wool recycling. Industrial clusters such as Prato can deliver a synergistic linkage of enterprises working to maximise material circularity by transferring and exchanging by-products that can be reused or recycled within the network (Talmon-Gross and Miedzinski, 2016; Pellizari et al., 2011).

3.3 Routes to the circular economy

Stakeholder results regarding drivers and barriers indicate that there are critical technological, political and commercial challenges to be overcome to enable textile circularity; including the adaptation of policy frameworks to fit innovative business models, and the development and acceleration of markets for end-products made from recycled textiles. A number of potential instruments to overcome these hurdles and promote circular textiles have emerged from this stakeholder research. Importantly, the shift from the currently predominant linear model towards the circular economy, including redesigned value chains, service models and product life cycles, will involve substantial transitional risks (e.g. transition delays, unexpected costs, service interruptions, skills demand etc.). For this reason, we have examined not only the range of instruments encouraging textile circularity, but also possible mitigation strategies to overcome the risks associated with transforming business models and value chains.

Table 3. Instruments cited by stakeholders to make circular textiles a viable strategy	Case Study Region	GM	HS	LS	NT
	Country	UK	FR	SI	IT
Network innovation		x			x
B2B partnerships		x			x
Reverse logistics		x	x		x
Financial and fiscal incentives to recycling		x	x	x	x
Standards (quality)		x	x		
Collection and segregation at source – taking in all textile products		x		x	
Accelerating market uptake		x	x	x	x
Consumer involvement (perception of recycled products)		x	x	x	x
Legislative instruments (landfill tax)		x	x		
CSR-schemes and positive branding			x	x	

Closing the textile materials loop will require innovations and changed practices that can only be implemented beyond individual and organisational borders. Through collaboration or network innovation, multiple players can join forces to develop new products and services, exploit new technologies, and share costs and benefits. Such collaborative frameworks can help to accelerate the uptake of new technologies (such as those developed within Resyntex) and to alleviate the risk-taking efforts by individual companies. They can take the form of B2B-partnerships such as joint ventures, but can also take shape within publicly supported “circular economy clusters”.

Collection of used textiles is a key stage in a circular economy textiles system, as end-of-life clothes and textiles returned for reuse, recycling and resale require an infrastructure for recovery and reprocessing, along with effective means to communicate across the supply chain. Main routes for textile collection include textile banks, charity shops, door-to-door collections and cash for clothes shops. Making use of all four methods of collection offers a wide range of donation options to consumers and serves to divert the greatest volume possible from municipal waste streams. Where existing infrastructure can be readily repurposed to work in a circular economy, such as where existing logistic networks can turn into reverse logistics networks, infrastructure barriers to the circular economy may be overcome at low cost (Benton

and Hazell, 2013). This could take the form of retail and residential delivery networks, which would back-haul collections of unwanted clothes and textiles.

For opportunities such as reverse logistics and closed-loop value chains to effectively materialise, more financial and fiscal incentives will be required to promote and encourage recycling. The stakeholder consultations led to a range of ideas, including an additional tax on retailers when using virgin materials and non-recyclable products, as well as increasing the waste incineration and landfill taxes. Other ideas included the introduction of tax breaks on repair and recycling activities, as was proposed in Sweden (Orange, 2016), and the instalment of EPR-schemes. Such schemes oblige all institutional and commercial actors that “produce” textile waste to manage their material streams and ensure that these textile products are led to the most effective reuse, recycling or remanufacturing route; and thus diverted from landfill or incineration.

A critical issue emerging in all case studies was the need to carve out markets for recycled products, while also stimulating consumer demand. Mechanisms to encourage the purchasing behaviour of recycled products should therefore be explored, including standardised labelling, circular public procurement, communication campaigns as well as fiscal and financial incentives to stimulate the market entry of recycled products and their competitive performance vis-à-vis virgin products and resources. Closed loop models show the most potential in business to business scenarios, where high volumes of uniforms or similar products can be easily and cost effectively retrieved. High material recovery costs can be offset when recycling becomes more cost effective, prices of virgin resources rise and when policy incentives such as EPR or tax breaks are in place. (Circle Economy, 2015).

Regarding consumer involvement, a lack of awareness of the need for textile recycling and a minimal understanding of the most responsible way to dispose of textiles have been shown to be common consumer issues (Morgan and Birtwistle, 2009; Goworek et al., 2012; Joung and Park-Poaps, 2013). Domina and Koch (1999) investigated consumer methods for textile disposal alongside the reasons for disposal and found that for damaged items of little or no value, recycling at home into rags was the most common answer (91%) followed by modifying and reusing (46%). While consumers may feel they are participating in sustainable behaviours by recycling unwanted items into rags, these items will inevitably end up in the bin.

Provision for consumers to donate low-grade textile items for mechanical and chemical recycling purposes separately to higher quality items is needed as a clear indication of the value of these items as part of a circular economy fashion and textiles system. Joung and Park-Poaps (2013) confirmed previous research, that donation was related to charitable concerns, and that discarding behaviour was related to convenience. Convenience and

accessibility have been noted as key to participation in recycling programmes. Higher level of participation have been recorded in communities with access to recycling programmes. When textile recycling was not offered as part of current recycling programme, consumers did not seek out alternatives as this was considered too much trouble. One survey found that people would not go more than 10 minutes out of their way to make a drop-off (Joung and Park-Poaps, 2013). Charity shops are recognised the most widely used method of donation for consumers (Gracey and Moon, 2012; Bartlett et al., 2013).

The circular economy paradigm allocates new responsibilities to consumers, as is also reflected in the outcomes of our stakeholder consultations. In the French Focus Group, suggestions were made to empower consumers and mobilise them in the sorting of textiles per fibre type prior to discarding of them. The limited reliability of garment labels does pose an important problem however to such consumer involvement in the sorting of textiles. Yet long before the stage of consumption and disposal, efforts to improve textiles' lifespan and environmental performance should start at the earliest stages of design and conception, making it imperative to agree on harmonised standards that ensure products are designed and manufactured with an eye to their subsequent end-of-life stages. These standards affect the choice of yarns and fabrics, of mixed materials (where particular consideration should be given to the stronger feasibility of mono-material recycling), of dyes, solvents and finishing processes.

Products that have a recycled material content should be labelled and certified clearly, to ease their market performance and broaden the knowledge and engagement of consumers. Goworek et al. (2012) found that individuals have little awareness of the sustainability impacts of clothing, with maintenance and disposal influenced by existing habits and routines. It was indicated that consumers could be persuaded to change their behaviour in relation to sustainability by being encouraged and enabled to reflect more on their behaviour, and that this could be facilitated by the provision of more information from retailers and the government (Goworek et al., 2012). Zane et al. (2015) recommended that companies who wished to make the ethical credentials of their products a selling point needed to have this information easily accessible and freely available, so that all consumers felt included in the message without feeling that others with more knowledge stand in judgement over them.

Communicating how good practice enables all stakeholders to be equally responsible for ethical choices would work towards a consumer understanding of shared accountability (Zane et al., 2015). Connell and Muthu (2014) have extensively reviewed consumer engagement levels in purchasing sustainable clothing and the links between knowledge, awareness and purchasing behaviour. More sustained marketing techniques are recommended to influence

consumers' perceptions of items made from recycled materials and which factors qualify the evaluation and acceptance of a product. Research conducted by (Bly et al., 2015) further points to the need to consider notions of style, authenticity and well-being in the outreach to consumers about more sustainable textile products, rather than the conventional focus on concerns of sustainability and ethical credentials.

Table 4. Transitional risk mitigation strategies cited by stakeholders	Case Study Region	GM	HS	LS	NT
	Country	UK	FR	SI	IT
Continued support to R&D		x	x	x	x
Guaranteed resource supply and price stability		x	x		x
Access to finance and investment				x	
Embedding sorting and recycling operations into existing infrastructure		x	x	x	x
Training and capacity-building of the entire value chain as well as public sector stakeholders				x	
Coordination and multi-stakeholder schemes		x	x	x	x

More needs to be done to accelerate the commercial exploitation of research efforts that currently remain confined to lab scale, including further research on the costs and benefits, scalability and Life-Cycle Assessment of currently available recycling techniques. More generally, further technology development and strengthening the commercial capability of textile recycling operations will inevitably require structural changes. The risks and costs entailed by these changes can be controlled by coordinating amongst all parties, designing and implementing strategies in a concerted effort, and sharing regular and transparent information on investment, performance and challenges encountered. Access to finance is another vital issue, as the often small and family-owned business in the textiles collecting sector cannot mobilise the capital required to invest into new recycling technologies. Solutions could be found in public-private partnerships but also in more innovative funding models, such as joint ventures with technology developers or partnerships with brands.

The respondents in our research were quick to point to the framework conditions of stability of supply and pricing, as a prime condition for a closed-loop model in which lower value textiles would be systematically collected and delivered to dedicated recycling plants. The outlook crucially hinges on market fluctuations, regularity of supply and resource prices, as these factors influence the economic incentive to recycle, and particularly the decisions to invest into recycling the more challenging fibre types. Stakeholders are generally concerned that the

already precarious collectors' profession will not be able to bear the burden of newly introduced costs related to collection and sorting, which may then not be compensated by the viability of the recycled products.

It is therefore all the more important to capitalise on the already existing infrastructure and expertise in transitioning towards more sustainable material loops. In all case studies, stakeholders underlined that a circular model will need to “keep it local”, reducing the carbon footprint and enabling an enhanced traceability and thus efficiency of the process, but also creating employment at the local and regional levels. The entire industry, from the local collector to the regional recycler, up to the global retailer, will therefore need to be trained and educated, in order to meaningfully engage with circular business models and to avoid any sectoral disruptions. Creating a common language and shared understanding of closed-loops, mechanical and chemical recycling and material needs is a first step towards more careful analysis and efforts towards retaining value of what is produced and collected, and this across the entire supply chain and waste management sector.

Lastly, and as outlined above, any effort in closing textile material loops will need to bring together policy, business, industry and research communities, to collaboratively drive and accelerate the needed innovations. Identifying the most relevant opportunities and barriers, as this paper has attempted to set out, is a first step in creating alignment and common understanding of the way forward. There is a strong need to get businesses and investors on board, but also to involve different government departments, ensuring that policy frameworks are best designed to serve the transition to enhanced material sustainability. As an example, and as emerged in the Haute Savoie case study, a single and coordinated institution could be created to oversee the generation and recycling of textile waste from corporate and professional sources. The mind-set summarised in “think global, act local” seems to be best-suited to accommodate these approaches. Large scale system and process change, involving the entire textile and garment industries and their supply chains, will need to be coupled with recovery and recycling on local and regional levels, working close to source, close to consumers and together with local stakeholders.

4. Conclusions

Findings indicate that until recently, the term ‘circular economy’ was unheard of in the profession of textile waste collection. The collection, recycling and disposal of textile waste has suffered from a traditional disconnect from the textiles industry, with end-of-life widely considered as merely part of waste management undertakings. The circular shift is however well underway, as confirmed by the stakeholder consultations carried out across Europe in

the framework of this research project. Stakeholder research investigated how current industry perspectives contribute to the wider understanding of how to integrate a new circular economy concept for textile recycling into existing practices. Circular economy strategies offer multiple environmental benefits by keeping resources in productive use for as long as possible. Investigating how to target the most often discarded and least valuable fraction of textile waste offers scope for more effective circularity in Europe. Through semi-structured questioning in a focus group format, stakeholder participants highlighted target issues in four main areas: barriers, drivers, opportunities and risks. Stakeholders were unanimous in their opinion that current textile recycling technologies were neither economically, technologically nor logistically viable in the current market situation. A lack of both consistent consumer demand for recycled products and appropriate legislative classification of textile waste were intrinsic problems to the adoption of fibre to fibre recycling.

Drivers cited for textile circularity were connected to triple bottom line impacts of environment, society and economics. Making both environmental and economic savings through the utilisation of waste as a resource and demonstrating societal obligation through extended producer responsibility (EPR) in the face of growing consumer awareness of ethical issues were felt to be strong motivators. Opportunities to optimise the system for greater circularity included legislative incentives such as the reclassification of textile wastes, landfill tax accompanied by fiscal incentives for recycling and official quality standards for recycled fibre content. Logistical strategies such as network innovation, partnerships and collaborations would work to accelerate adoption and enable opportunities such as reverse logistics and closed loop value chains to function across circular economy industrial clusters.

Consumer involvement in circular economy textile strategies presents both opportunities and risks in closing the material loop. An opportunity to increase collection rates by mitigating against the risk of textile disposal into municipal waste streams exists but needs to be backed by appropriate strategies. Consumers are increasingly aware of environmental and ethical issues connected to textiles and clothing, yet engaging the majority of citizens in responsible disposal and consumption behaviours has proven a challenge to industry thus far. Creating convenient and accessible solution for individuals to separately dispose of both decent quality re-wearable and low grade non-wearable clothing and textiles in residential, retail and municipal waste sites provides the widest range of options to engage citizens in textile collection activities. Further research is recommended to investigate which collection strategies would be most readily adopted, and how to best engage and motivate citizens to utilise such services on a regular basis.

Risks involved with increased textile circularity cited by stakeholders include those to financial and market security for those engaging with emerging technologies and networks. Stakeholders felt these risks could be mitigated with support for research and development, training and capacity building and the co-ordination of networks and stakeholder schemes. Such support would need to be a joint initiative between government and industry partners, as well as those with technical and research expertise.

As described by Kant Hvass (2016), the textile industry will need to move from a product-specific (focused on the reuse of garments) to a material-specific approach (focused on reuse and recycling of particular materials), in order to seize the circular opportunities for cascading textiles. As emerged from our research, closing the loop will require collecting the necessary volumes in a manner that guarantees price and quality consistency, while reaching an appropriate, ecologically sensible and commercially viable, scale of operations. As outlined above, the removal of regulatory uncertainties and barriers around waste and secondary resources, the investments in research and technology, the involvement of consumers, and the cross-industry collaboration will be key to establishing such closed-loop models.

Stakeholders consulted in the context of the Resyntex project have called for an “economies of scale” approach in transitioning towards circular practices in the collection and processing of textiles. Indeed, a material-specific approach will entail collecting large volumes of disparate textile materials, meaningfully structuring the processing of items ranging from apparel to fabric leftovers and fibre fills. Policy incentives that can contribute to such paradigm shift include EPR-schemes and tax breaks on repairing and recycling activities. In order for collectors’ business models to expand to *all* textile materials however, greater volumes will need to be achieved, as well as markets large enough to absorb the end-products resulting from the recycling processes. Only by scaling up the collection, sorting and recycling of textiles can the threshold value be surpassed and can textile “waste” be transformed into a market-friendly secondary resource.

At the same time, it was argued that closing the textiles loop should ideally occur within local and regional units of collection and recycling. The tighter the circle, stakeholders stated, the easier to organise supply chain logistics, with a potential role for “Internet of everything”-technologies which enable tracking and flow analysis of discarded textiles, as well as tangible benefits such as local job creation. Urban environments, with a high density and proximity of retailers, consumers and waste collectors, show great potential for reverse logistics and closed-loop business models, reducing transport costs and associated externalities such as carbon emissions and energy consumption (World Economic Forum, 2014). In addition,

organisational alignment, cross-value chain collaboration and an innovation-friendly policy environment can be easier to carve out on local and urban levels.

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