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Reverse Logistics Model for Post-consumer Textiles View project

Original Article

Developing a national programme for textiles and clothing recovery

Mohammad Abdullatif Bukhari¹, Ruth Carrasco-Gallego¹ and Eva Ponce-Cueto²

Abstract

Textiles waste is relatively small in terms of weight as compared to other waste streams, but it has a large impact on human health and environment, and its rate is increasing due to the 'fast fashion' model. In this paper, we examine the French national programme for managing post-consumer textiles and clothing through a case study research. To date, France is the only country in the world implementing an extended producer responsibility (EPR) policy for end-of-use clothing, linen and shoes. The case highlights the benefits of using an EPR policy and provides interesting insights about the challenges faced by the textiles waste sector. For instance, the EPR policy has contributed to a threefold increase in the collection and recycling rates of post-consumer textiles since 2006. In addition, the material recovery rate of the post-consumer textiles can reach 90%, 50% of which can be directly reused. However, the 'reuse' stream is facing some challenges because its main market is in Africa and many African countries are considering banning the import of used textiles to encourage a competitive textiles industry locally and internationally. The EPR policy shows a great potential to identify new markets for 'reuse' and to improve the textiles waste sector. Such an EPR policy also could drive societies to financially support innovation and research to provide feasible solutions for fashion producers to adopt eco-design and design for recycling practices. This paper provides guidance for policy makers, shareholders, researchers and practitioners interested in diverting post-consumer textiles and clothing waste from landfills and promoting circular textiles transition.

Keywords

France, circular economy, clothing reuse, extended producer responsibility, resource recovery, textiles waste management, sustainability

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Introduction

In recent decades, natural resource efficiency and management have become an area of major interest for researchers, policy makers and practitioners to close the material loop and to contribute to the circular economy transition. Unlike the linear model for 'take-make-dispose', the circular economy is intended to be restorative and regenerative by having better product design and processes to promote maximum reuse of resources and prevention of waste. The European Waste Framework Directive (2008/98/ EC) sets the basic concept of waste management by introducing the waste hierarchy in the following priority order: prevention, preparing for reuse, recycling and ultimately disposal (EC, 2008). It also sets the material conservation target to be achieved by 2020; that is, diverting over 50% of municipal waste from landfills by preparing for reuse and recycling. In 2016, the EC proposed new targets substituting the previous Waste Framework Directive by a Circular Economy Package, setting the recovery target for municipal waste to 70% and limiting the share of municipal waste to be landfilled to 10% by 2030 (European Parliament, 2017). To achieve the targets, Member States must introduce an extended producer responsibility (EPR) policy for particular products such as batteries, vehicles and electrical and electronic equipment (EC, 2015). As a result, producers of these products bear the cost of the collection, treating and recycling their end-oflife products. Member States are allowed to extend the use of the EPR policy for other waste streams to stimulate more waste collection and recovery. So far, the application of the EPR policy for the textiles industry is not a common practice. The first legal framework for manging textiles waste using the EPR policy was declared in France in 2007, which aims to hold textiles producers responsible for collection and recycling end-of-use (EoU) clothing, linen and shoes.

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Figure 1. Estimation for the annual amounts of landfilled textiles in different countries in 2016.1

Apparel consumption has increased dramatically during the last few decades. The current business model, the fast fashion, characterised by mass production, variety, agility and affordability, has been adopted by large international fashion retailers. According to Pedersen and Andersen (2013), fast fashion creates a demand for 80 billion new garments each year (Cline, 2013). Fashion retailers attract consumers by offering and selling a wide variety of styles, colours, and materials at very affordable prices. Every year, Americans consume nearly 20 billion new garments (Cline, 2013). According to the American Apparel and Footwear Association (2017), an average American bought around 68 garments and 8 pairs of shoes in 2016. In 2014, the average expenditures on apparel in the US and EU were about \$1786 and $\in 621$ per capita, respectively (Bureau of Labor Statistics, 2016; European Environmental Agency, 2014).

The development of a long-term national programme that is environmentally and financially sound could improve the current behaviour of clothing consumption and waste generation (Ekström and Salomonson, 2014). Since France has a national programme for textiles recovery, this case research can contribute to a great understanding of different aspects of managing post-consumer textiles. The main research questions we address are:

- (1) Who are the actors of the textiles waste recovery in France?
- (2) How are textiles and clothing collected and recycled?
- (3) Does the EPR policy improve the collection and recycling rates?
- (4) What are the barriers and challenges that hinder the development of circular textiles industry?

For this, we adopt a case research method because it is effective for an in-depth examination of such practices as it helps gather a clear understanding of the issue being studied (Stake, 1995; Yin, 2013). The study is based on analysing the data found in the annual reports of the French producer responsibility organisation (PRO) of the textiles industry in relation to the information discussed by the experts in the sector's panel discussion '*Fachtagung der Gemeinschaft für textile Zukunft*' that took place in Germany in November 2017. During the conference, we conducted unstructured interviews to address specific issues that the sector faces. Intensive secondary data has been examined during our study that includes journal papers, technical and working papers, news, magazine press, official national legislation websites, charities websites, fashion retailers' annual reports and textiles recycling organisations' publications.

The paper is organised as follows. The following section gives a background of the textiles waste and its recovery benefits. We also highlight different arguments and discussions regarding the EPR policy implementation. Next, we introduce the French case study of the national programme for recovering post-consumer textiles and clothing. In this case study, drivers and actors for the textiles recovery are examined in addition to the textiles recovery activities such as collection, sorting and recycling. Then, we discuss our findings and highlight major challenges faced by the sector. Finally, some recommendations for future studies in textiles recovery programmes are given, followed by our conclusions.

Background

Landfilling of textiles waste

The amount of textiles waste sent to landfills and incinerators is enormous and it is increasing. According to the European Commission, European consumers discard around 5.8 million tonnes of textiles every year and only 26% is being recycled (Beasley and Georgeson, 2014). The amounts of annual textiles waste that goes to a landfill in the UK and the US are estimated to be 350,000 tonnes and 9.5 million tonnes, respectively (WRAP, 2012). Similarly, about 100,000 tonnes in Hong Kong and 20 million tonnes in China are being landfilled annually (China National Textile & Apparel Council, 2013; Kao, 2015). Thus, China and the US landfill larger amounts of textiles per capita compared to Europe and the UK, as shown in Figure 1. From 2005 to 2014, the US generation of textiles and clothing waste increased 40% (see Figure 2). The graph also shows the rapid increase of the amount of textiles waste generated between 2010 and 2014. Moreover, the total cost of managing the textiles waste rose from \$2.4 billion in 2003 to \$3.5 billion in 2013 and might reach \$4.5 billion in 2020 (Johnson and Adler, 2017). The cost of the textiles waste sent to landfill is about \$45 per ton in the US (Wicker, 2016) and €60 per tonne in some countries in Europe, including France (EC, 2002).



Figure 2. Textiles waste generation in the US, based on Environmental Protection Agency data (EPA, 2014).

Member States are required to reduce the amount of wastes sent to landfill. The EC Landfill Directive 1999/31/EC enforced Member States to reduce the disposal of biodegradable municipal waste to landfill to 75% by 2006, to 50% by 2009 and to 35% by 2016 (EC, 2016a). The objective of the directive is to protect human health and to reduce the environmental impact on surface water, groundwater, soil, air and on human health from the landfilling of waste. The directive also requires Member States to introduce stringent technical requirements for waste sent to landfills. The European Commission has proposed to reduce landfill to a maximum of 10% of municipal waste by 2030 (EC, 2016b). Thus, finding alternatives for diverting textiles from landfill is not only necessary to achieve that target, but also to increase the materials efficiency, which is a vital element for promoting circular economy.

Extended producer responsibility implementation

The EPR has been defined by the Organisation for Economic Co-operation and Development (OECD) as an environmental policy approach in which producers are responsible (physically and/or economically) for the collection, treatment, and disposal of their products at the post-consumer stage of a product's life cycle (OECD, 2001). It aims to drive and incentivise producers to: develop a sustainable production system and product design to make them durable and easier to repair and recycle; develop innovative techniques for recycling processes; and create new markets for recycled products (EC, 2015). In the EPR setting, producers can either develop their own individual collection and recycling system, or can join a collective scheme, where different producers contribute to a PRO to leverage economies of scale. However, researchers argue that the collective scheme does not offer enough incentives for promoting waste prevention and green product design (Atasu and Subramanian, 2012; Esenduran and Kemahlioglu-Ziya, 2015; Plambeck and Wang, 2009).

Different accreditation systems for collective producer responsibility exist. The EPR policy was initially established with a single PRO operating as a monopoly such as the previous German dual system for packaging. Evidence of inefficiency and cost increment has led to an increasing number of EPRs that involve multiple PROs. On the other hand, it has been argued that EPRs having monopoly PROs can benefit from exploiting economies of scale, addressing free-riders and reducing the costs of regulatory oversight (OECD, 2016). The conditions in which a monopoly PRO is more efficient than multiple PROs have not been determined. This study gives more insight on the EPR implementation of a single non-for-profit PRO, accredited as a PRO for the textiles industry.

Textiles and clothing recovery in France: case study

Drivers and actors

France has the largest surface area in the European Union (EU), with more than 67 million habitants (Eurostat, 2017). It has an ambitious target for textiles waste collection and at the same time is struggling to achieve the European Commission's waste management target, i.e. 50% recovery of solid waste. France has set a 50% (about 300,000 tonnes, 4.6 kg/person/year) collection target for the annual sales of clothing, linens and footwear in addition to reaching more than 95% of material recovery rate for the collected textiles (European Environmental Agency, 2016). As of 2017, France is the only European country in the world that has introduced an EPR instrument for textiles, linen and shoes.

The EPR policy for textiles was introduced by the *Article L-541-10-3 of the Code de l'Environnement*, which came into effect on 1 January 2007 (Legifrance, 2015). Since that date, according to the new legislation, all legal entities presenting new textiles and clothing in the French market (i.e. garments, footwear and household linen) are held responsible for recycling or proper disposal of their products. Those entities – which include textiles and clothing manufacturer importers and distributors – can accomplish this legal obligation through two distinct ways: either by financially contributing to an accredited PRO or by setting-up an individual take-back programme approved by the French public authorities. Publication of the decree in the journal officially specifies how to implement the law and the need of establishing eco-organisation, PRO, which took place in June 2008 (Legifrance, 2008).

Product	Size Category	Examples	Tariff (€)		
			Regular	Eco-module(1)	Eco-module(2)
Garments & linen	Very Small Item	Socks, kids' underwear	0,00132	0,00066	0,00099
	Small Item	Shirts, leggings, lingerie	0,00528	0,00264	0,00396
	Average Item	Pijamas, nightdress	0,00791	0,00395	0,00593
	Large Item	Adult's jacket, coat	0,0528	0,0264	0,0369
Footwear	Small Item	Slippers, mules	0,00528	0,00264	0,00396
	Average Item	Shoes, boots	0,00791	0,00395	0,00593

Table 1. Tariffs for 2016 members' contribution (n - 1 = 2016), based on Eco TLC (2016b).

The PRO for textiles, footwear and linen (Eco-organisme du textiles, du linge et de la chaussure) was introduced in December 2008. It is for the moment the only accredited organisation to manage this sector waste. It is a not-for-profit private company constituted by 29 associates (associés). The associates represent the whole textiles value chain and are organised in five 'colleges': (a) general large retailers (e.g. Auchan, Carrefour, Monoprix); (b) fashion retailers (C&A, Galeries Lafayette, Etam); (c) direct sales and mail/online retailers (Damart, Groupe 3SI); (d) manufacturers and wholesalers (LVMH, Cotonflorlinge du lit); (e) apparel industry associations (Federation Nationale de l'Habillement, Union des Industries Textiles). The Board of Directors of the PRO consists of 12 legal entities, each nominating a representative. The legal entities are Armor Lux, Auchan, Blanche Porte, Carrefour, Cora, Decathlon, Eram, French Federation for Clothing Brands (FEH), Galeries Lafayette, Monoprix, Okaïdi (ID Group) and Vivarte. Two representatives from the Federations Committee - French National Clothing Federation (FNH) and French Textiles Union (UIT) - also belong to this board. The Board currently is presided over by Jérôme Obry, representing Okaïdi (ID Group), whose term of office is three years (2014-2017) (Eco TLC, 2016a).

Apparel manufacturers, importers and distributors can register as members (*adhérents*) of the PRO to fulfil their EPR liability. In 2017, the PRO was able to collect the financial contribution from 4476 members that introduced 564,000 tonnes of textiles, linen and shoes in the French market in 2016 (Eco TLC, 2016a). All members are listed on the Eco TLC website (http://www.EcoTLC.fr/).

The tariffs for members' contributions are calculated every year, depending on the previous year's expenses. Members' contributions are received in the first quarter of the year (n) and are based on the number of units (and their size) put by each member company in the market during the year (n - 1). Tariffs consider four different sizes for garments and linen (very small, small, medium and large) and two sizes for footwear items (small and medium). The PRO incentivises textiles producers by reducing the annual tariff when they use recycled fibres made from preconsumer or post-consumer textiles, linen and shoes. Producers a 50% discount over the normal tariff if their products have a proven minimum composition of 15% of post-consumer recycled

fibres or materials (see tariff in Table 1). They can also benefit from the 'Eco-Module (2) Tariff', a 25% discount over the normal tariff if their products have a proven minimum composition of 30% of pre-consumer recycled fibres. To be eligible for an Eco-Module tariff, the PRO examines supporting documents, provided by the main producer, that prove the type of recycled components, the origin of used material, and their proportion in the composition of the new products (Eco TLC 2016a). Member companies whose revenue is under €750,000 or sell less than 5000 items in year (n - 1) are entitled to contribute a fixed tariff of €36 plus VAT (Eco TLC, 2016b).

Collection schemes

Post-consumer textiles collection in France is handled in different channels. However, on-street textiles containers are predominant. The containers are owned by more than 200 organisations - authorised charitable and commercial organisations. Some of the organisations provide pick-up 'door-to-door' services to collect unwanted clothing and shoes and/or textiles banks in private areas, like supermarkets, shopping malls, and private parking spaces. Consumers can also take their clothing to charities or one of their shops. Many flea markets exist to help consumers sell their private items including used clothing. Wearable clothing in good shape might be taken to and sold to thrift stores. Some fashion retailers, such as H&M, provide a trade-in take-back collection system, where consumers can deposit their clothing in a collection box located inside their stores to get a discount voucher to use for their shopping. Eco TLC monitors mainly the outlets that collect unsorted clothing and shoes, such as on-street containers, charities, authorised recycling organisations, H&M, charity shops etc. Nowadays, used clothing sold in some of the online websites and smartphone applications such as eBay and letgo is not monitored by the PRO.

The French PRO mainly monitors the channels of which sorting and recycling are required. On-street collection containers, charities and their shops, and take-back collection shops are all shown in the map that displays the nearest collection points. The PRO has launched an interactive website and mobile application to educate consumers on how to recycle their clothing properly and show them the nearest collection points around them (www. lafibredutri.fr/je-depose). Those on-street containers hold a label

Financial support	Qualifications		
(€ 65 per tonne) for re-use and recycling	To be a separate legal entity		
(€ 20 per tonne) for energy recovery	To comply with the installations requirements of the Protection of the Environment Law.		
	To ensure traceability in upstream (including collection) and downstream (including export) of the sorted materials		
	To achieve the sorting performance level defined by the authority		
	To ensure financial transparency of its accounts		
€ 50 to € 125 per tonne	Efforts are made to increase the sorting capacity Integrating and hiring workers who are in difficult social situation		

Table 2. Qualifications of sorting agencies for receiving financial support from the PRO, based on Eco TLC (2015).

Table 3. Recycling performance, based on Eco TLC (2015).

Recycling performance requirements	
Material recovery rate > 90% Recycling rate (unravelling) > 20%	
Final disposal rate without energy recovery < 5%	

includes the owner address and authorisation number as well as two logos, one for the owner and another one for the PRO.

Sorting and recycling

Collected materials are shipped to a facility where sorting and recycling take place. Container holders organise their collection and transportation independently. Collected clothing arriving at the charities is either sold in their shops, donated to people in need, exported to global second-hand markets or sent to sorting facilities. Once the materials arrive at the facility, all items are scaled and registered before getting sorted. Then, materials are sorted, recycled, and stored in the warehouse ready to be dispatched. The PRO registered 64 authorised sorting facilities in 2016, 50 of which are located in France and the rest are distributed in Europe (Eco TLC, 2016b).

The sorting and recycling facilities are owned by private organisations. A major share of collected clothing is managed by not-for-profit organisations, such as Le Relais and other members of the EMMAÜS community. Le Relais alone has 18 sorting facilities in France, while there are 9 facilities owned by EMMAÜS members. Sorting facilities outside of France can also sign agreement with the PRO to receive financial supports as described below. Currently, 14 sorting and recycling facilities are operating outside of France; most are based in Belgium and the Netherlands.

Sorting and recycling terms are sometimes used interchangeably. In our context, sorting is the process that comes before recycling which aims to classify and separate textiles, clothing and shoes in a systematic manner depending on certain criteria. Sorting of textiles will determine the material destination and the processes of which textiles is going to be recycled. On the other hand, recycling is the processing of the sorted materials to change their current forms to be used as an input when producing new products. All registered recycling facilities use mechanical processing for textiles. The typical textiles mechanical recycling processes are: unravelling, grinding, defibrating and cutting. Recycling organisations can benefit from the subsidy provided by the PRO, if they fulfilled certain conditions and contract terms (Table 2).

The contract terms ensure that recycling organisations are legally authorised and willing to provide accurate information regarding collection, sorting, recycling, and re-distribution of the sorted materials. They should also show financial transparency of their accounts and meet the following recycling performance (see Table 3). First, they should achieve more than a 90% recovery rate. Most of the recycling organisations can reach this rate. The recovery rate is the fraction of the total quantity of collected and sorted materials diverted from landfill and incinerators. Second, the recycling rate should be more than 20%. The recycling rate is the fraction of the sorted materials that are not wearable. Third, the waste that goes to landfill or incinerators without using energy recovery should be less than 5% of the collected and sorted materials (Eco TLC, 2015).

When efforts are made to increase the sorting capacity as well as hiring workers who have a difficult social situation for finding a job, additional supports of \notin 50 to \notin 125 per tonne is applied. The main objectives of subsidising the sorting and recycling are to monitor and trace the textiles flow and to enable recycling organisations to: improve their performance; increase their sorting capacity; and improve the sorting and recycling performance. After sorting and recycling the textiles and clothing, recycling facilities sell the recovered materials to their corresponding markets. (Eco TLC, 2015).

Results and discussion

The PRO role for improving the sector

The EPR policy in France has accredited the PRO to drive sustainable improvements of the national post-consumer textiles collection and recycling. The PRO should comply with the EPR policy and collect a tariff from the producers of textiles, linen and shoes to manage the EoU textiles. For that, the PRO has focused on the following issues: (1) raising consumer-awareness, (2) connecting stakeholders in online communication platform, (3) increasing



Figure 3. Material flow of post-consumer textiles in France.

containers availability and accessibility (4) improving recycling rate, (5) identifying a textiles recovery standard, (6) improving transparency of the financial and material flows related to textiles industry, (7) supporting research and development in the sector, (8) encouraging fashion producers to use pre-consumer or postconsumer textiles for producing new garments.

Therefore, several agreements with fashion retailers, local communities, collection point holders, and sorting and recycling organisations have been taking place. Fashion retailers can benefit discounted tariff if they proved specific post- or pre-consumer material contents in their new products. The local communities, all over France, have been financially supported to launch awareness campaigns for the public, and to encourage availability and accessibility of the collection points. The sorting and recycling sector has been financially supported to facilitate transparency of the material and financial flows of the sector. An independent third-party verifies all the declarations of the sorting operators. The PRO dedicates part of the budget to encourage technological innovation as well as social integration. All the PRO activities and results are reported annually to the State Authorities and communicated to the public. By examining the annual reports of the PRO, the flow of materials in France can be described.

The material flow of used textiles in France

In this study, the flow of textiles waste has been characterised (see Figure 3). Consumers are the first component in the used textiles value chain. Thus, consumer-awareness is a key for raising consumer interest in buying second-hand clothing and disposing their used clothing properly. The ease, accessibility, and availability of outlets for selling used clothing such as flea markets, thrift stores and online markets would raise consumers' participation in second-hand trades. In addition, social and environmental awareness would encourage consumers to donate their clothing to charities and to drop-off their clothing in the specialised containers for a good will. The used textiles placed in these containers, then, gets sorted and recycled into different products - second hand clothing, cleaning rags, insulations for construction and automobile industries, etc. In 2015, the 'reuse' stream was about 65% of the overall collected textiles. Most textiles in this stream exported to the second-hand market in Africa and few were sold in France. Also, around 35% of the materials were down-cycled (9% to produce rags and 24% to produce insulation materials) and about 6% were either landfilled or incinerated. Approximately, 70% of the rags markets were located in Europe (31% in France and 41% outside France), and more than 80% of the insulations markets were located in Europe as well (44% in France and 38% outside France). The final channels for each sorted group are shown in Figure 4 (Eco TLC, 2015).

Current and future challenges for 'reuse'

The market for 'reuse', the most preferred option for textiles recovery, has been shrinking in the last few years. Discovering new markets for 'reuse' and increasing second-hand clothing demand in Europe are challenging but critical. The quality of new clothing is becoming lower and the export of clothing is becoming more difficult (recycling expert, 2017, personal communication). The 'reuse' stream is 10 to 15% less than what it was three years ago and African markets are demanding better quality (recycling expert, 2017, personal communication). Many Asian and African countries have considered banning the import of EoU materials. For instance, used clothing imports have been outlawed in the Philippines since 2016 (Export.gov, 2016). In 2015, Philippines imported used clothing by \$31.7 million. China also announced that the imports of several wastes will be banned at the end of 2017. The ban will be on 24 types of waste,



Figure 4. Redistribution of post-consumer textiles and clothing in France, based on Eco TLC (2015).

including EoU PET, PVC, polyethylene and polystyrene, mixed waste paper, used textiles (China's Ministry of Environmental Protection, 2017). Some African countries believe that the import has impacted their domestic production of clothing in the region. For instance, in Kenya, the garment industry that previously employed 500,000 persons has only 20,000 workers presently. Thus, countries in the East African Community (EAC) are considering banning the import of used clothing by 2019 (BBC News, 2016; Mayer, 2016; Omondi, 2016).

The African countries have been a potential for the 'reuse' market for many years. Our data shows that more than 40% of the post-consumer textiles collected in France were exported to African countries in 2015. According to Oxfam, more than 70% of the clothing donated globally has been sent to Africa (Kubania, 2015). Cameroon and some countries from the EAC are the largest importers of second-hand clothing. In 2015, the EAC imported second-hand clothing that was worth more than \$150 million (BBC News, 2016).

Challenges for textiles sorting and recycling

Sorting and recycling of textiles suffer from system cost and inefficiency. The current markets for recyclable textiles and clothing are limited. Also, sorting of textiles is very expensive and it is time and labour intensive (Sherburne, 2009). The use of different fibre blends has made clothing difficult to sort and recycle (Hawley, 2009). Development of automatic sorting technologies that are economically feasible for used textiles and clothing is still under development. On the other hand, advanced recycling technology is required to replace or complement the inefficient mechanical recycling. The mechanical system cannot close the materials loop and it diminishes the fibre length and strength (George et al., 2006). Thus, recyclable textiles are mainly downcycled to produce wiping clothing or insulation products that can be used in construction and auto industries. Automation of sorting and discovering new technologies for textiles recycling, e.g. chemical recycling, have been given more attention recently and developed systems are expected to shine in the near future.

The benefits of the EPR policy for postconsumer textiles and clothing recovery

The EPR policy for post-consumer textiles helps the textiles recycling industry to overcome future challenges and create jobs for socially excluded workers. Sorting of textiles has provided 1,400 full-time jobs in France as of 2017, among which 49% has been reserved for workers facing employment difficulty (Eco TLC, 2016a). The PRO is financially support the inclusion of excluded workers. The EMMAÜS community, the biggest notfor-profit community in France, takes a large share of sorting and recycling of clothing and aims to promote the inclusion of excluded workers into the labour force. The community believes that the practices of textiles sorting and recycling are opportunities to hire large numbers of a low-skilled workforce because they are labour intensive (Le Relais, 2017). Sorting and recycling organisations are not financially stable because the quality of collection and the demand for used clothing are not always the same and the price of used clothing is fluctuating. Only 30-40% of the collected materials can cover the recycling cost (recycling expert, 2017, personal communication).

The tariff contribution paid by fashion retailers and producers is relatively small and valuable for establishing the infrastructure for used textiles collection and recycling. In 2016, fashion retailers introduced 2.5 billion pieces to the French market, including 93,000 pieces of eco-modulated clothing. The share of clothing, linen, and footwear were 82.3%, 6.9% and 10.8%, respectively. According to that, by applying the tariff schedule, the PRO collected €17.2 million from the members (an average of €0.0067 per piece and €28.7 per tonne) in 2016. This contribution was used to cover the following 2015 expenses: €477 thousand spent in projects finance, €2.1 million subsidised local communities for consumer-awareness campaigns, €12.8 million in subsidies paid to charities and private organisations for sorting the collected textiles and clothing, and little budget spent in taxes, staff, offices and outsourced services (Eco TLC, 2016a).

The collection and recovery rates of post-consumer textiles have been increasing since 2006. As shown in Figure 5, the average annual increase of post-consumer textiles collection is about



Yearly collection of post-consumer textiles and clothing (Thousand Tonnes)

Figure 5. Annual increase in collection of textiles and clothing in France, based on Eco TLC (2016a).

13% since 2006. The amount collected now is three times as much as what was collected 10 years ago. In 2006, 65,000 tonnes were collected while around 210,000 tonnes were collected in 2016. This increasing trend may indicate that the PRO has improved the issues of consumer-awareness, numbers and accessibility of on-street collections bins, and the transparency of material and financial flows. The number of textiles containers in 2016 (41,793 containers owned by around 375 entities) was more than twice of what it was in 2011 (15,621 containers owned by around 150 entities). There is a national target to improve the citizens' accessibility to the textiles bins by placing a minimum of one collection bin for every 1500 inhabitants by 2020. (Eco TLC, 2016a)

The EPR policy increases the financial supports for raising the public sustainability-awareness and participation. In 2015, the PRO subsidised \notin 2.1 million to engage 760 local communities to maintain public communication campaigns (Eco TLC, 2016a). It has also established a website and mobile application to allow the citizens to find the closest textiles containers to drop-off their used clothing. The online platform also provides information regarding the social and environmental benefits of the textiles recycling.

Recent studies of textiles recycling show that reuse and recycling are more beneficial for the environment than landfill and incineration. Zamani et al. (2016) have compared the potential of greenhouse gas (GHG) emissions and energy savings of the textiles incineration with different recycling techniques using life cycle assessment. He has found that the textile recycling has a much higher potential of GHG emissions and energy savings. In addition, according to Dutch aWEARness's calculations, textiles recycling cuts raw materials demand by 61% and can promote energy, carbon dioxide and water savings of 64%, 73% and 95%, respectively (EC Eco-innovation, 2017). It cuts raw materials demand by 61% and, because it is fully recyclable, waste is eliminated entirely. Innovation and creativity are keys for promoting circular economy.

The French PRO dedicates annual budget of €500,000 to foster innovative projects (Dubois et al., 2016). Many projects have been financially supported to improve the current sorting and recycling activities. Every year, the French PRO calls for new projects to give opportunities for researchers and institutions to participate and share their innovative ideas and turn them to reality. Approved proposals and projects get funded, up to 50% of the total cost, and communicated in a document called 'Roads to innovation' (Eco TLC, 2017). As of 2017, 28 projects have been launched that can be categorised into four project areas: 2 ecodesign projects, 6 closed-loop projects, 14 open-loop projects and 6 projects in used textiles sorting and processes techniques (Eco TLC, 2017). The aim of the current eco-design projects is to develop a new procedure for shoe design and manufacturing to permit easy separation of all components at the post-consumer stage. The closed-loop projects aim to create yarn from used materials such as jeans, socks, polyester and shoes. The openloop projects aim to facilitate downcycling used textiles for decorative and industrial use. Finally, the sorting and processes projects seek new methods for textiles sorting and separating of hard components.

The PRO activities to maintain sustainable improvements in the textiles sector are great, but there are still a room for improvement. Despite a 50% discount on the tariff that has been offered for these items, the discount remains too low to cover the administrative costs linked to the declaration per unit and the certification of the origin of the recycled material used (Eco TLC, 2016a). Thus, fashion retailers find it infeasible to report their clothing made out of post-consumer textiles. In addition, they find it easier and more feasible to report and use pre-consumer materials obtained from textiles production waste (Eco TLC, 2016a). We observe that the PRO does not give producers incentives such as eco-module tariff when they ecologically design and source other materials. However, this might be very complex and requires another system to monitor such practices.

Paper limitation and some recommendations for future studies

This paper gives a qualitative examination on the national postconsumer textiles recovery in France and identifies new gaps for future research. The paper doesn't assess the efficiency of the EPR policy implementation in France. However, it highlights its benefits and limitations. Future investigations, for instance, might focus on quantitative assessments for the French EPR model for textiles and clothing and its implementation consequences to specific actors. In addition, more focus could be given to the PRO practices such as: How are material and financial flows monitored? How can better decisions be made on the tariff rate? How can different stakeholders engage together to support further collaboration? Do we need to dedicate an increased budget for R&D? Moreover, researchers could discover to what extent does the optimised reverse distribution network benefit the current practices and how to make it work in practice to benefit all the actors in the network. The French PRO doesn't manage and optimise the reverse distribution network for collection routes and sorting facilities' locations, which implies that collected textiles might not be transported to the closest recycling facility even though smaller loops (collection, re-use, and recycle) are generally more profitable, eco-friendly and resource efficient, due to less transportation distance and other transaction costs (Stahel, 2013).

Conclusion

Promoting a circular economy is one of the biggest challenges that our societies face. In this paper, we highlight some of the challenges that hinder the circularity of the fashion industry and the opportunities the EPR policy creates for the society and its textiles sector. The post-consumer clothing recovery has suffered from different challenges like decreasing demand of reused textiles from potential markets within Africa and Asia, expensive and labour-intensive sorting procedures, and the use of different fibre blends in the textiles making it difficult to sort and recycle. We also observe that 40% of the post-consumer textiles collected in France are exported to African countries for reuse, which raise sustainability concern on African textiles market development. Downcycling of textiles is possible but does not provide sufficient resource benefits so that technological innovation is required to promote upcycling and to reuse post-consumer materials for producing new products.

Adopting and efficiently implementing EPR policy for post-consumer textiles can improve the collection and recycling rates as well as identifying solutions for current and future challenges. Since its commencement in France, the EPR policy has led to an average annual increase (13%) in the postconsumer textiles collection. The policy can also facilitate collaboration between different actors and can support research and development in the sector to solve different issues that both fashion producers and recyclers face. In 2016, the French PRO collected €17.2 million from fashion retailers for introducing more than 2.5 billion pieces to the French market. The tariff received has been employed to mainly: (a) support recycling organisations to promote increasing collection and recycling rates, (b) maintain transparent material and financial flows, (c) fund research and development projects to identify solutions and create opportunities for textiles producers as well as recyclers and (d) support social inclusion for socially excluded workers. The French implementation of the EPR policy provides a model, for which other countries can follow to sustain improvement in the collection and recycling rates, transparency in the sector, consumer-awareness, technological innovation, social enterprises, stakeholders' communication and information sharing. The development of the sector may require more participation, more initiatives, and more shareholders partnerships from other countries to work together to achieve circular textiles industry. The research highlights important insights for researchers, policy makers, and practitioners that can help them to improve the current EPR implementation for post-consumer textiles recovery to gain economic, social and environmental benefits.

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Note

 We have considered the mid of 2016 to the estimated population figures from different sources. The population data for the US, China and Hong Kong have been obtained from the Population Reference Bureau (http://www.prb.org/pdf16/prb-wpds2016web-2016.pdf). The EU, UK and France data from Eurostat statis tics (http://ec.europa.eu/eurostat/statistics-explained/images/d/de/ Population_and_population_change_statistics_YB2017.xlsx).

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