HÖGSKOLAN I BORÅS

re:textile

Assessment Report- Life prolong used textile Business models

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Introduction

Textile & Clothing (T&C) are one of the most polluting and resource-draining industries in the world, next only to oil, in terms of environmental impact (Fletcher 2008, DEFRA 2008). This is driven largely by environmentally unfriendly production practices. Textile waste, identified as the fastest growing stream in the household waste (Defra 2007), causes significant damage to the environment at landfill sites. According to Nordic Council of Minister over 100 000 tonnes of used textiles are already collected each year in Denmark, Finland, Norway and Sweden. This is mostly carried out by charities to fund their charitable activities. Around three quarters of these textiles are sold on global markets (Norden 2017).

The per-capita yearly consumption of clothing and textiles in Sweden is about 15 kg (of which about 9 kg is clothing) (Palm, 2014). SMED (Swedish MiljöEmssionsData) has similarly studied that Swedes annually throw approximately 7.5 kg textiles per person in the unsorted household waste that is incinerated (Naturvårdsverket 2017). The random sampling in this study shows that around 60 percent of textiles in residual waste are intact and unworn and could be reused. The study also was focused on examining what proportion of fabrics that have a higher risk to contain dangerous substances, it may be sporting, working, rain or casual clothing and textile with plastic printing. About 10 percent of the fabrics consisted of textiles in these product categories. 58 percent of the fabrics consisted of products of pure cotton.

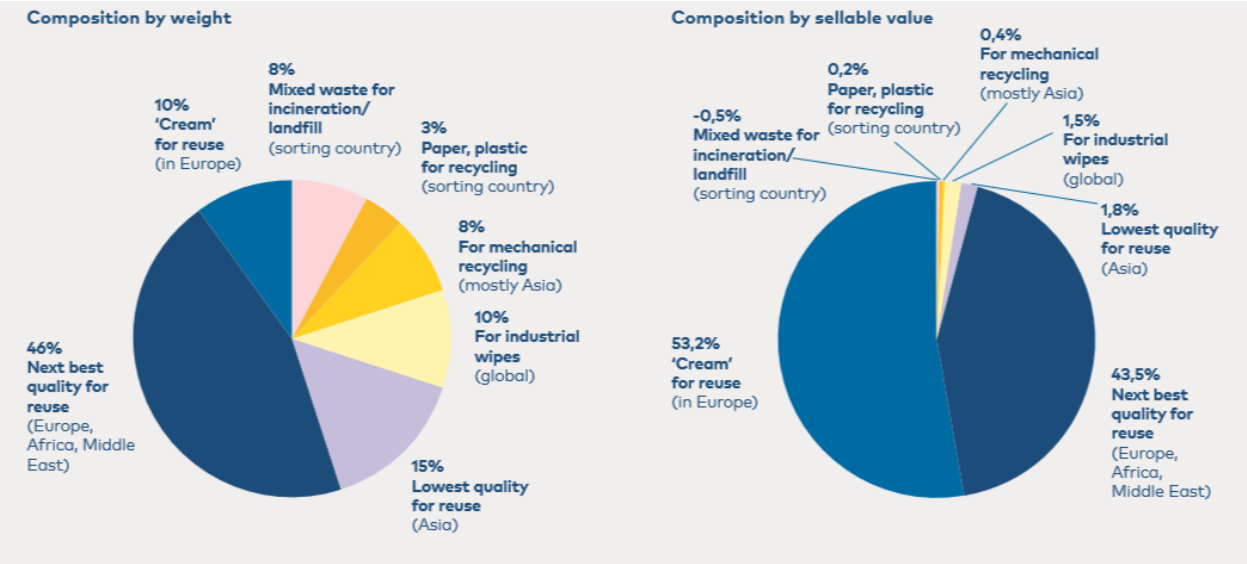
When it comes to recycling, a much lower volume is recorded. Carlsson et al. (2011) suggest that each individual disposes about 8 kg of clothing and textiles into the garbage (ending up for energy recovery), while roughly 3 kg are reusable and collected by charities, and the remaining 4 kg either accumulate (e.g. in a closet or wardrobe) or are handled through other means of waste management (e.g. recycling centres). However, this calculation is underpinned by the assumption “in = out”.

On an average, the distribution of the collected T & C volume through charities in Sweden in terms of quality is as follows – Prime/cherry-picked (~20%), East Europe (10-15%), Africa (10-20%), Rags (~20%), Recycling (~20%), and Waste for energy incineration (~10%). Income is to a large extent based on export of second and third fractions, of two different grades destined for Eastern Europe and Africa, respectively. Residual fractions are used for the production of rags, recycled by mechanical or chemical methods, or discarded as waste, where energy recovery is the preferred result.

According to the statistical data, exports of worn Nordic textiles increased from 60,000 tonnes in 2011 to 75,000 tonnes in 2014. In addition, around 2,800 tonnes of rags were exported. However, Falling prices for used textiles in recent years have ensured that a high share of used textiles are reused and recycled. Collectors and sorters of used textiles can no longer make ends meet by just selling the ‘cream’ and next best quality for reuse. They need to squeeze out every last penny by also selling the lowest grades for reuse and recycling. Since reuse yields a higher price than recycling, and recycling yields higher prices than other waste treatments, economic signals also

ensure that the waste hierarchy is met. As a result of reduction in used clothes exporting there will be considerable potential (volume) for more reuse and recycling activities like remanufacturing, redesign, repair and refurbishing in Norden countries and consequently development of innovative business models for product recovery in near future.

Figure 1. Typical Post-sorted Composition of Exported Nordic Textiles (Norden 2017).



Moreover, product recovery could be achieved in three ways; material recovery for recycling or reuse, value added recovery for remanufacturing, or energy recovery for incineration (Guide et al. 2003). Reuse or recycle of used cloths reduce the environmental impact significantly in comparison to the purchase of new garment (Woolridge et al. 2006). As closing the materials and product cycles is one objective of sustainable consumption and production, remanufacturing is becoming an increasingly important aspect among the recovery options (Michaud and Llerena 2006). When it comes to remanufacturing in textile industry, sorted used clothes provide a proper response to demand of both resellers and remanufacturers as a raw material. They can be beneficial to resellers and recyclers, who are seeking for a specific type of fibre composite (e.g. polyester or cellulose based fibres) or stock keeping unit (white t-shirts), etc.

Therefore, depending upon various collection and sorting schemes these reusable clothes can be classified into various categories by the global sorters and each category calls for specific business models (products, customers, value proposition, partners, etc.).

Corresponding business models are classified in different manners, for instance based on final production groups they can be classified as:

TYPE I: Reusable clothing

Sorted used clothes provide a proper response to demand of both resellers and remanufacturers as a raw material. Unlike original used clothes they can be beneficial to resellers and recyclers, who are seeking for a specific type of fibre composite (e.g. polyester or cellulose based fibres) or stock keeping unit (white t-shirts), etc. Depending upon various collection schemes these reusable clothes can be classified into various categories by the global sorters. However, the generic schema is the same in most cases, as highlighted below:

- "Very good, hardly worn, fashionable clothing" is classified as Quality Extra or Europe quality.
- "Good, wearable clothing" is classified as Quality Nr. 1 or Export 1 quality.

Remaining material is sold as Quality Nr. 2/3 or Export 2.

TYPE II: Non-woven products

This group of products is manufactured through mechanical recycling (cutting, shredding and melting of clothing and textile waste). Some of the renowned companies working with mechanical garment recycling are: Wilson Knowles & Sons (UK); Dell'Orco & Villani (Italy); Textiles Techniques Chaudières Appalaches (Canada).

There is a diverse range of products which can be made with this procedure, e.g.:

- Industrial towels/wipes, building materials (e.g. Dafecor is a Finnish company producing these items through mechanical carding of used textiles).
- Insulating tapes
- Barrel-protection mats
- Oil-stops and other materials for managing harmful substances
- Acoustic, thermal insulations, e.g. ISOA's (France) cotton wool flakes, Buitex's (France) Isonat cotton wool flakes, Soprema's (Canada) drainage panels, etc.

TYPE III: Semi-processed raw materials

This group of products includes shredded and cut fabric and fibres which can be sold to other manufacturers. Recycling producers, car manufacturers and furniture producers illustrate examples of the prospective buyers.

Various consumer goods are also produced by using these shredded materials like:

• Rags

• Cushioning and filling materials

• Stuffed toys, insoles, bags

• Recycled denims (with recycled yarns), e.g. G-Star (Netherlands) is making jeans out of 50% recycled material.

These business models are also known as product life extension business models which allow companies to extend the lifecycle of products and assets. Value that would otherwise be lost through wasted materials are instead maintained or even improved by repairing, upgrading, remanufacturing or remarketing products.
In those processes, value is predominantly restored or added by sufficient rework on the products, hence the original value retention of the product is low thus demanding higher labor intensity to recreate "new" value (Stahel 2007). Various reuse- and resell- based business models can be identified in the second hand clothing sector. Pal (2015) has identified 7 different resell-based business model types in used clothing networks in Sweden, such as: Collection-based, Direct re-selling, Business-to-business (B2B) re-selling, Second-hand retailers and so on, which will be further explained in the following section of this report.
Re:Textile and Loop Koop are two examples of projects which have been seeking to evaluate and design similar business models in mentioned categories in Sweden.
Re: Textile initiative is funded by the Västra Götaland region and Boras - Sjuhärad municipal and it operates via collaborations among the Science Park Borås, Marketplace Borås and more organizations, companies and entrepreneurs in western Sweden.

The main ambition of Re:Textile is to develop structures for circular processes in the textile industry. The goal is to create new business opportunities and use less planetary resources. The long term goal admittedly is Design for Re:Design: products and business models with a prolonged life. Re:Textile aims to work with companies and organisations through workshops to find new redesign ideas and business models establish Re:Design Factory, a consortium for realization of redesign and to investigate the feasibility studies in areas such as national sorting centre for textiles in Sweden and remanufacturing in an industrialized level.

Loop Koop project is a project started by the three charitable organizations Stockholms Stads Missonen, Hela Manniskan and Verdandid. This project is an attempt to suggest solutions for challenges such as careful and responsible handling of textile waste and unemployment. This project aims to reach a circular business model which reflects on these challenges by offering six different services, respectively, collection, transportation, sorting, secondhand shops, exporting of used textiles, up-cycling (redesign, remanufacturing) and down-cycling for its wide range of clients. Loop Koop consumers could differ from municipalities in need of a proper collection and recycling system, to shops or companies which are seeking for an efficient withdrawals system or even organizations, institutions and manufacturers who are looking for a specific type of material or product.

The main emphasis of Loop Koop business model is placed on down-cycling. The term down-cycling refers to the time when used textiles do not have the condition or lack the good quality to be either reused or redesigned. Such cases are therefore recycled and manufactured into new type of products, regenerated new fibers, mechanical recycled products such as insulations or padding materials to name a few.

The main purpose of this report is to assess the potentials of developing product life extension business models on the account of the outcome of the two given examples of the ongoing projects in Sweden and also on the international scales. To perceive a better understanding of these business models functionality, a brief review of the required activities and processes is conducted.

Methodology

This report is conducted on the basis of the outcomes of the two projects, Re:textile and Loop Koop. Documents such as Loop Koop business plan and financial report, Re:textile feasibility study and Interim Report and alike were used. Additionally, further data have been obtained through other secondary materials such as open sources, authors' related experiences and other ongoing projects. Literature review gave the study a solid ground and increased validity.

Recent changes in the economics of used textiles in Nordic countries

This section is an extract from *Export of Nordic Used Textiles* report, the chapter of *The Economics of Used Textiles* (Norden 2017).

The flows of used textiles from Nordic countries tend to follow the market according to price. Flows respond rapidly to changing supply and demand globally. The flow of textiles can be viewed as a cascade of quality from countries with high incomes to countries with increasingly lower incomes. The cream, meaning the highest quality, remains in Europe, mostly in Eastern Europe, often in the same countries where there are sorting operations. Quality grades A and B and tropical quality tends to be exported to Africa and the Middle East (but also in Eastern Europe and Latin America). The lowest grades are exported to Asia for reuse and recycling.

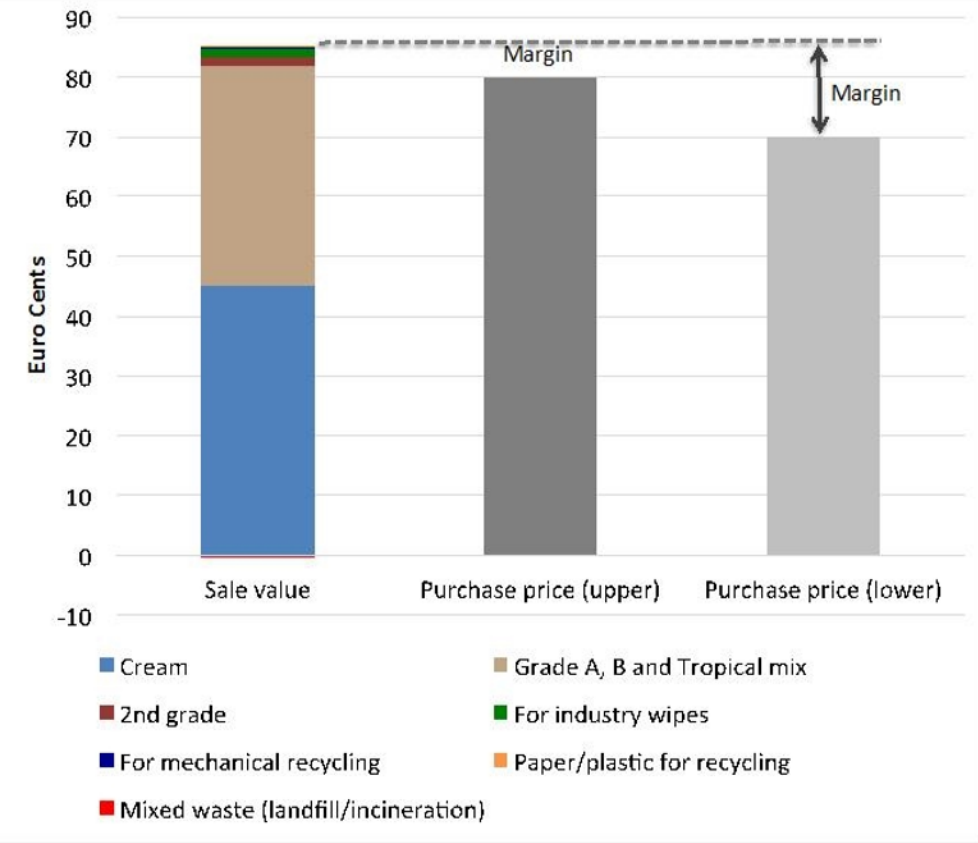
The richer a country is, the less inclined the population is to buy lower quality secondhand. As global economies develop the used textile cascade shifts its course then it can be said that ultimate destination, economic development has also affected price. For example, whereas at the beginning of the millennium in Poland 80% of the textiles that were exported there for sorting, were sold on the domestic market, but according to some reporters this figure may have dropped to 40% or lower as Polish citizens became wealthier. The textiles that once would have been consumed there are now exported to Ukraine, Romania or further afield where they are still in demand.

Until a few years ago there was a high demand for used textiles on the global market and a lack of supply to meet it. More recently, as a result of economic growth, the situation has reversed. There is now a glut in supply in Europe but a drop in domestic demand. Wholesalers also reported that

at the end of the quality cascade, in Pakistan for example, buyers are also becoming more selective in what they accept. These trends have led to an overall drop in prices. Contrary to expectations, this drop in prices has not had the effect of reducing reuse and especially recycling activities, quite the contrary. A decade ago the high prices meant that sorters/wholesalers could make a profit just by selling the cream and second grade and the rest could be disposed of in municipal waste. The fall in prices for second-hand means that wholesalers/sorters need to squeeze every cent out of the original they receive from collection organisations (or the raw material as they call it).

In the following the economics for a typical sorter in Poland bar chart presents the sorter must pay between 70 Eurocents and 80 Eurocents/kg for original. But the total sellable value of a kg of original after sorting is around 85 Eurocents The 5–15 Eurocent margin must pay for transport from the collector, payback on investments in the sorting facility, rent of land/space, use of energy for machinery and most importantly, all sorting staff. This latter is the highest cost factor. If the sorter only sold the cream and Grade A and B, the margins could reduce to as low as 1 Eurocent. Therefore although sorter makes very little money from the lower grades and textiles for recycling compared to the cream, selling these are crucial to increasing his margin.

Figure 2 the economics for a typical sorter in Poland. (Norden 2017)



The lower wholesale price for used textiles has also had an effect on the diversity of the second-hand sector. In Poland, narrow margins mean that only the more effective and established sorters and wholesalers have survived; overall numbers of sorters, wholesalers and retailers have diminished significantly. While narrow margins have ensured that all parts of the exported original are reused or recycled, thus reducing environmental risk, the same narrow margins can also act as a driver in pressing down wages of people working in the sector. Whether this happens or not depends on wage policy in receiving countries, the levels to which these are enforced and also whether the employers or their clients have CSR policy, codes of conduct etc. These issues are examined further in the socio-economic assessment. The end fate of textiles reported in the study countries gives a very similar picture when the jigsaw puzzle pieces are fixed together to the overview already received from Myrorna/Fretex and Humana/UFF. Since the end fate of textiles is guided by economics rather than by codes of conducts we can assume that the high reuse and recycling shares reported by these organisations are typical for the exports as a whole.

Steps towards reclaiming value

A commercial chain for used clothes requires several steps for reclaiming value, viz. collection and sorting, refurbishing (e.g. repairing, washing etc.) and is sometime followed by value adding steps like redesigning/upcycling, through a series of interconnected complex reverse logistics (RL) activities led by a number of different actors, such as retailers and resellers, charities, commercial sorters/recyclers. Used clothes regain new value for new purposes and customers, as clothes or sometimes into alternative forms. Mapping of the flow of used clothing reveal that majority of these actors are involved in the collection process along diverse channels, thus resulting in a very fragmented structure prevalent. For instance, fashion businesses run all these reverse value chain activities, either single-handedly by arranging both take-back of used clothes followed by reselling them through various retail formats, or by getting involved in collaborative networks with a number of other partners to carry them out. Once an unwanted garment has passed through collection, sorting, and possibly further steps of labor practices, it re-enters the commodity form, as a reused item or as a redesigned product. The residues that cannot be exported, sold or redesigned are consequently recycled or incinerated (Ekström & Salomonsson 2014).

Collecting

Separate collection rates in Nordic countries of used textiles vary from 22% in Sweden to 46% in Denmark with the majority of the remainder ending in mixed waste streams for incineration. Used textiles collection is predominantly carried out by charities to generate income to fund charitable activities. A large proportion of the collected textiles are sold on the global market.

Second-hand retailers and charity organizations are by far the largest collectors of reusable clothing in Sweden accounting for a yearly per-capita collection of nearly 1.8 kg. This accounts for nearly 16,000 tons of clothing being collected yearly by the ten largest second-hand retailers

and charities in Sweden. A small portion is also collected by fashion retailers through their recent engagement with in-store collection activities. H&M, for example, one of the largest collectors among them, collected just over 3,000 tons of used clothing (worldwide) in 2014. Unsold clothes are also sent to the charities (<0.1 kg per capita yearly).

The collection system for used clothing in Sweden is highly fragmented with many actors, who engage with collection via various channels: Traditional street collection and kerbside containers, In-store collection systems and Recycling stations.

Collection may be considered as one of the salient processes in the closed-loop supply chain. The future of the close-loop supply chain largely depends on the quantity and quality of collection. Contemporary methods used to collect textile scrap are namely manual method and container collection.

Indeed, every company is trying to collect best quality of products, in order to do this, they use various innovative techniques. Sweden has always emerged as a leader in the development of new technologies and innovations. A mobile application, Cirqle, has been developed, which tells consumers about the nearest location of a charity organization and retail store, which collects used textile products. In similar notion, the Swedish fashion brand "Uniforms for the Dedicated" have developed THE RAG_BAG. The bio-degradable shopping bag can be made into an envelope by turning it inside out. A proper postage stamp with the address of the charity organization helps consumers to easy donations. A new initiative has been taken to develop a national test centre for textile recycling at Wargön, Sweden. The laundry industry in Sweden has also initiated advanced sorting technology together with for instance Jensen Group. University projects have started with the purpose of developing new sensor technology for identifying toxic additives and fibre contents in textiles.

Additionally, as an example of collaboration for the act of collection among stakeholders it can be mentioned that some clothing brands and retailers act as middlemen between consumers and commercial collection and sorting companies, and hence the clothing is not sorted but directly sold/donated (e.g. H&M and KappAhl's collaboration with the global sorting company I:CO). Others are selective about which garments they accept, due to internal processing for new value creation through reuse and/or redesign (e.g. Boomerang, Nudie, Filippa K).

Sorting

Sorting of used clothes classically is clustered in three main categories , manual, semi-manual, automated, as well as various ongoing initiatives aim at developing new mechanical and chemical sorting techniques to ensure better recyclability. Mechanical sorting techniques include use of barcodes (for checking productivity of manual sorting, or price tagging), RFID (in retail stores and warehouse management), optical Near In-fra-Red (NIR) for detecting fabric composition and color, e.g. Textile 4 Textile project (Alkazam 2013), and even Robotics by integrating haptic and visual sensing, and recognition (CloPeMa 2015). One of the recent initiatives taken has been the

FI- BERSORT program using NIR Spectroscopy, jointly undertaken by Valvan Baling Systems, Metrohm, Worn Again, Fairtex, Reshare and Circle Economy. Such initiatives not only highlight the process innovation and design in activating circularity but also show how choice of right partners and collaborative networks play a crucial role in bringing together complementary expertise of the actors in several areas. The FI- BERSORT project, in this regard, involves strategic partners like Valvan for sorting machineries, Metrohm for NIR scanning, Wieland Textiles for second-hand textile processing, among others. (Re:textile 2016)

Extraction of value from waste through sorting process involves subjectivity. This may be because the process is heavily dependent on the decision-making ability of workers. Currently, decision-making regarding sorting of textile products in Sweden is mostly manual. Charity organizations are by far the largest collector and sorter of used textile in Sweden.

The collected material is sorted by the charities and second-hand retailers in own facilities to take out the top quality garments which are generally resold "as they are" in Sweden, while the rest is exported. It is worth mentioning that export provides lower incomes compared to selling the garments for reuse in Sweden. Additionally, activities such as remanufacturing are believed to maximize the profit two times more (Narsar and Thurston 2006). The sorting generally in Swedish charity organizations takes place in two phases, initial and fine, to end up with ~10-20 different SKUs.

Additional to what mentioned above as Re:textile has noted in Planning a Swedish Collection and Sorting Plant for Used Textiles (2015), developing a second-tier sorting facility at the national or regional level in Sweden, along the triple bottom line of economic, social and environmental perspectives, can be identified and beneficial as follow:

- *Economic motivation:*
    - **Profits:** Establishment of a second-tier sorting location in Sweden would facilitate the retention and selling of used clothes left after the major collectors have collected and cherry-picked the items (~20% of the collection volume). Presently, this volume is exported outside Sweden by the charities at a very low cost (1-2 SEK/kg). Competitive trading of these used clothes in the export market instead would give a better price (~4-5 SEK/kg), hence profitability to all involved actors engaged with the network, compared to what the charities currently sell for. Connected to down-cycling or remanufacturing this can be a rather unique business idea in the Swedish context.

    - **New products:** Establishment of a second-tier sorting location with associated research and development (R&D) could help to development novel and innovative products, like non-woven and semi-processed materials with multiple technical and functional uses (mentioned in detail in the section "Products and services"). Commercialization of these products can be profitable in the long-run. Currently, Sweden does not have any remanufacturing plant or facility, thus representing a white space for new product innovations.

- *Social motivation:*
  - **Job creation:** A second-tier sorting facility can create many job opportunities regionally. Further, realization of subsequent down-cycling or remanufacturing can boost development of domestic production, also resulting in additional job creation. This is in particular a positive aspect amid increasing migration of refugees in Sweden.
  - **Regional upgradation:** A second-tier sorting facility can motivate the development of vocational programmes and schemes to educate the newly created workforce, of various disposition and remanufacturing activities. This can enhance the knowledge intensity over time, resulting in development of a regional "smart specialization".
- *Environmental motivation:*
  - **Resource efficiency** (moving up the EU waste hierarchy): Development of a second-tier sorting facility is expected to appropriate a sufficient amount of used clothes, which otherwise would end up for incineration or perhaps even landfill, which forms the lowest level in the EU waste hierarchy. Second-tier sorting can improve the scope of remanufacturing, which can result in attaining higher resource efficiency, hence lower utilization of virgin materials.

Value adding mechanisms

There are five mechanisms to recover the value of used products: repair/reuse, refurbish, remanufacture cannibalisation and recycle; which are appropriate in recovering the value of used textiles. The biggest impact on reducing environmental burden is in extending and keeping clothes out of landfill. (Dissanayake and Sinha 2015)

In Sweden different stakeholders in textile waste management are involved in the process of recovery the value in used textiles. For instance, some charities in Sweden work with redesign in small-scale projects, but not regularly. However, they do provide material to small redesign brands, both sorted and unsorted. Studio Re:design was such an initiative, funded by Västra Götalandsregionen (Region of West Sweden). Generally the redesign brands receive material from charities with whom they (sometimes) collaborate in projects. Products which have lost their functional value generally tend to form part of material left for recycling. These products are sorted based on colour and fibre composition. All kinds of trims (zippers, buttons, etc.) are taken out from the clothes before extracting fabric or yarns. Mechanically, clothes are cut or shredded to make wipers and rags. To extract fibres and energy, chemical and thermal recycling, respectively, is made. In some cases even mechanical recycling is made to generate fibres out of used textile. However, more than one technology is used to make non-woven products like carpeting and composites.

Market perspectives and business models

As it has already mentioned in the introduction, a high portion of used textiles is exported to international markets. In recent years, as a consequence of constant development and economic progress in the receiving countries their demand for the used textiles has been reduced. Since, they have successively generated second-hand textiles from their own sources. In other words, the profit of the 80 % residual textiles after cherry-picking will be decreased, as it is export-based. Thus, considering the impact of different measures, it appears that the greatest potential is to be found in the development of new technology and novel business models for the collection and sorting activities to extract the most amount of value from used textile even the 80% residual textiles after cherry-picking.

Concepts such as Circular Economy also builds on ideas of generating better economic performance with new (circular) business models along these closed loops that focus on selling services instead of products to product life extension (via remanufacture, resell, repair, etc.) to lower resource usage (Wijkman & Rockstrom 2012), thus having the potential to generate an economic growth between 1% and 4% in many western economies in the near future (ING Economics Department 2015).

Various reuse- and resell- based business models can be identified in the second hand clothing sector. Pal (2015b) has identified 7 different resell-based business model types in used clothing networks in Sweden, these are:

- Collection-based, like fashion retailers (with or without reverse logistics partners) engaged with take-back and 'swapping' schemes through their retailer shops, e.g. H&M in collaboration with I: Collect. Kappahl and Indiska similarly collect used textiles in their in-stores collection boxes. The value proposition in this action is the voucher, or special discount on next purchasing that the customer receives.

  Swapping clothes has become very popular during the last decade in countries such as United States of America. There are varied platforms such as websites, phone applications and social events-meet ups- which encourage people to exchange their belonging, either on-line or in person. Some of these initiatives ask for membership fee, however, this is not the case with all of the named platforms. This act will aid the customers to Re-fashion their wardrobe in exchange with their old clothing items and consequently save costs and reduce the planetary damages.

  As an example of this emerging phenomena, an online platform called ReKindness can be mentioned. ReKindness is a social enterprise which swaps clothing through its online platform and strives to tackle the problems associated with logistics, negotiating and visiting the post office. The credit system replaces negotiation, since members only pay for shipping and handling. (ReKindness 2017)

  Members upload photos of an item they are willing to give away and choose a credit value based on a scale of 1 to 5, from inexpensive to a "super premium" brand. Another member can choose the item and will pay for the shipping to have the item sent to them. The item

donor will then receive community credits to "spend" on any item in the community closet, paying only the shipping and a small handling fee to keep the ReKindness site up and running. ReKindness claims that the platform eliminates the two biggest painpoints of these types of transactions

Melanie Kovach, the funder of this platform believes:

"Swapping isn't just good for the wallet, it's good for the Earth. Swapping clothes can help reduce the 21 billion pounds of textiles that are sent to US landfills every year." (sustainablebrands 2017)

- Direct reselling, when the retailers collect only its own brands and partly resell them through own shops. Swedish fashion brands like Boomerang, Filippa K, Haglöfs and Hope also take back their own brands from the customer. This deposition of used clothing is generally conducted by providing discount coupons to customers, which may be used for the next purchases. Further, Nudie Jeans is Swedish denim brand which offers multi-functional business model for its post-consumer products. It offers free repair service, redesigning and reselling second hand products and finally it recycles its own worn out products (Nudie Jeans 2017).

- Business-to-business (B2B) reselling, when the retailers collect but sells to other actors in the chain, e.g. to second-hand retailers.
- Charities, those have a hybrid business model, and partly resells the collected clothes, e.g. Red Cross. In the Nordic countries, the charities are the largest collector of second-hand clothes and nearly 20% of it is resold by them through their own shops while nearly 50-70% is exported to various destinations (Eastern Europe, Asia and Africa depending upon re- covered quality).
- Second-hand retailers, function more or less the same way as the charities, except for the fact that they are totally commercially oriented. Similar to charities they also engage in partnerships with various actors in the network, like with fashion retailers, charities, refurbishers, like laundries etc. Cheap Monday and Weekday are examples of international Swedish second hand retailers, having stores in different countries in the world (Cheapmonday, 2017).

- Redesign brands, which have the potential to offer higher value-added used clothing through high degrees of redesign and reconstruction of the old clothes.
  Kallio is a consciously-created kidswear brand based in Brooklyn, New York that "makes old clothes young again. Founded by Karina Kallio, a fashion industry veteran with an entrepreneurial flair, the brand repurposes men's dress shirts into stylish, modern classics for kids, ages infant to 8-years-old (Kallionyc 2017).

- Reclaimers, which mainly collect and resells leftovers from fashion retailers, or sometimes fashion retailers do it themselves by selling through factory outlets, e.g. Branting is a Swedish brand which de-brands its left- overs and sales them.

It is to say that, in most cases reuse and resell business models account for reducing carbon footprint of new garment manufacturing and energy usage by displacing the production of 'new'. Swedish Environmental Protection Agency (2017) has identified the effects of such displacement, in terms of reduction in carbon footprints by about 1, 5, 1 and 0.5 person equivalents/ton, and reduction in primary energy usage by 2.5, 1.75 and 1 person equivalents/ton, for substitution by factors of 1, 0.66 and 0.33 respectively.

As mentioned above, there are 7 different common reuse and resell-based business models currently working in Sweden. The following sections are based upon two examples of the ongoing projects, Re:textile and Loop Koop in Sweden which are being operated on the basis of the given business models.

Remake, redesign

As example of reuse and resell business models, the highest possibility for value creation along such fashion closed loops can be achieved via remanufactured fashion. Remake or remanufacturing, in general, refers to the process of reinstating a discarded product back to its useful life by upgrading so that it at least equals the newly manufactured ones in terms of quality; hence the life span is extended (Savaskan, Bhattacharya & van Wassenhove 2004). Many such initiatives have started worldwide and are predominantly led by niche and small-scale redesign brands. What differentiates remanufactured fashion from that of upcycling is the focus towards process industrialization compared to that being craft-based in case of upcycling design (Sinha, Muthu & Dissanayake 2015). The desirability of remanufacturing fashion is high considering the degree of value-addition, scope to create employment, and lower use of energy and material as well as minimizes the use of virgin materials and therefore recognized as one of the best methods for "closing the loop" with high value addition.

Recent initiative, e.g. Stockholm Stadmissionen's Remake is working along this direction to develop redesign-make strategies and methodologies. However, the main criticisms of such reverse value chains is that it will drastically increase the transportation from dispersed points of collection to the sorting and remanufacturing facilities, followed by lack of industrialization of the processes leading to considerably high costs of production (Mont 2008). But such transportation is required more or less along any closed loop for flow of the product, either share or reuse.

According to Re:textile Interim Report 2016, the main challenges in remanufacturing are in regards with operational and technical hurdles such as: Product non-modularity, unlike mobile phones or computers, making it difficult to dis- and reassemble. Also, variability in the collected used clothes is extreme, in terms of type, style and composition, quality and condition, cleanliness, making the process of remanufacturing difficult to standardize, repeat and scale-up. Further, retailing of remade clothes is difficult as this may conflict with the mainstream sales, marketing and pricing strategies.

Sinha et al. (2009) and Pal in Re:textile Interim Report 2016 commonly argue, main challenges for developing the remanufacturing process need to be investigated such as:

Implementation of a reverse logistics systems, development of sorting, disassembly and remanufacturing facilities and process (material analysis, sampling, creative pattern drafting and cutting techniques and production planning, etc.), new business models (digitalization, alternative sales channels, sharing etc.) and the strategies to access the market (marketing Innovative collection planning Co-creation, 'New' SKU definition, Innovative sales and branding, etc.).

In light of industrialization as stated by Pal (2016) in Re:textile Interim Report, to reach certain degrees of process repeatability and business scalability potential, solutions ought to be prescribed describing future considerations for designing two types of fashion remanufacturing value chains focused towards mass market and mass customization. These considerations will combine various reverse logistics and product remake-design aspects, technology considerations, retailing & marketing strategies, and consumer study into a business model for circularity of used clothes. In particular, the economic implications and feasibility will be assessed for such remanufacturing business models which will take into account crucial factors, such as key processes and value propositions, collaborative relationships, new technologies, customers and markets in their ongoing projects.

Product-Service design

The unification of product and services is heralded as product-service system (PSS). Potentially alternative business concepts such as renting, redesigning, up-grading, etc. aim at reducing the reliability on natural resources and at the same time strive for improved product longevity by extending the value of tangible products through intangible services (Mont 2002, Tukker & Tischner 2006).

In clothing PSS, Armstrong et al. (2015) have highlighted such schemes, e.g. take-back, repair & redesign, renting, clothing swaps etc. and their potential environmental effects through increased dematerialization and product longevity. Janigo and Wu (2015) have asserted how repair and redesign services can stimulate higher product longevity, Pedersen and Netter (2015) have shown the effect of fashion libraries in Scandinavia by promoting collaborative consumption. Many industrial examples of adoption of servitization in used-clothing sector can also be found, e.g. fashion renters like Rent the runway, take-back schemes arranged by fashion retailers and I: Collect, Scandinavian fashion libraries like Resecond, Klädoteket, UK-based redesign platform like Wardrobe Surgery, etc. Key design elements for such PSS are: value-adding services, product leverage, collaborative partnership, information transparency, awareness and platform-enabled networking (Pal 2016 (forthcoming).

Similarly, Design & Alter is a team of highly experienced and creative professionals from the tailoring, fashion and fitting industry based in London for over 20 years. Design & Alter offers different range of services from garment alterations, made-to-measure and restyling clothes. They

work with individual customers, luxury fashion brands and high profile VIPs; Design & Alter supports catwalk events, and some of its clients regularly appear on red carpets, on screens and in the pages of fashion magazines (Design & Alter 2017).

Mechanical & Chemical recovery

Down-cycling idea arguably can be suggested as one of the most effective approaches towards the preferable business model. For instance, down-cycling requires circular suppliers who provide waste of one industry as the raw material of another and help to extend the product's' life by means of recycling. It is through stages such as recycling, remanufacturing, reusing and redistributing that down-cycling leads to regeneration of capital, where a wide range of products can be created via either closed-loop (recycled to the same product) or open loop (recycled to a secondary product) recycling of textiles are four main methods: mechanical recycling (cutting, shredding and melting of C&T waste), chemical recycling (raw material), thermal (energy Ethanol, Biogas) and mixed technology (carpet, composite).

Mechanical recycling can be in form of defibrillation/thread opening process which is carried out by breakdown of fabric to fibre through cutting, shredding, carding, and other mechanical processes. The fibre is re-engineered into value added products. Textile materials which are defibrillated are mainly not thermoplasts (cotton, wool, and aramids lately). Mechanical recycling is also possible for thermoplastic polymers that can be melted and re-extruded, such as polyester and nylon. To obtain a polymer of equal value as the raw waste material the contamination of waste has to be very low. This approach is used for example in making fleece clothing from recycled PET-bottles (Vadicherla & Saravanan 2014).

Examples of mechanically recycled products contains a wide range, for instance, padding absorbing liquid, absorbent cotton, oil absorbent mats, mattress padding, wadding, padding for packaging, insulation felt, bituminous roofing membranes, protective sheeting for painting, pipe safe joint, filling material (cushioning, car seats), covering blanket, industrial wipes, brushing filler, felts, mats for underground watering, soil reinforcement agent, filtering, rags (cleaning rags), carpet, carpet underlay, mattress, etc.

An example of a mechanical recycler enterprise can be given from VRK-acoustics (2017). This Dutch recycler produces acoustics and insulation from mechanical recycling of Jeans and Denim. The average growth of turnover for this company according to its marketing manager, is estimated to be 70% per year. Its average margin in the year 2016 was 38, 4%.

Loop Koop project strived to investigate in analysis of the production and marketing of these product groups. The outcome of this project illustrated that these product groups can fulfill the demand of different industries, namely, building and construction, car, furniture, agriculture, graphical operations and public arts. Also, manufacturers whose raw material is used clothing and textiles can benefit from the provided products. Recyclers, as well as producers of carpets, rags, rugs, wallpaper and belka (interior wall coating) besides felt and industrial pads, can be

representative of another target customer. In addition to industries and manufacturers, organizations or institutions whose activities are concerned about emergency and disaster management, art schools and studios, entrepreneurs, municipalities, environmental organizations, hospitals, shelter houses, dormitories, and laboratories can be considered as the prospective customers. Loop Koop's research and analysis on product cases in Swedish market depicted that there are high success potentials for product groups such as Cleaning Wiping and Rags.

Similar initiatives can be seen in recovering value from end of a product life cycle through chemical recycling, e.g. UK-based Worn Again is developing a chemical textile to textile recycling technology and have partnered with retail brands like H&M and Kering (Worn Again 2016); Finnish initiative called Relooping Fashion is in the process of closed-loop ecosystem based upon a cellulose dissolution technology to create new clothing out of recycled cellulose and involves various strategic partners along the value chain representing crucial operations like collection, sorting and recycling, retailing and distribution (ReLooping Fashion 2016). Pure Waste, a Finnish brand, and partner in the Relooping Fashion initiative, is involved in this process in developing clothes out of industrial wastes (cutting wastes and leftover of the manufacturing process), which is then sorted by color, refibered and finally spun into yarn (Pure waste 2016). Another innovative network-based initiative, the Dutch aWEARness, is taken by various strategic partners like eco fabric producers, work-wear resellers, tracking and tracing partners, etc. to deliver circular workwear to various resellers. Dutch aWEARness works as a circular supply chain content manager by maintaining a database with information about materials, and includes a Life Cycle Analysis, a purchasing and inventory management tool and a track and trace system, and in turn receives a service charge (Dutch Awearness 2016).

Compared to recent recycling cellulose projects and initiatives, synthetic fibers have been recycled for a considerable longer time. Returnity is a 100% recyclable polyester fabric licensed by Dutch aWEARness, used for making workwear and interior-furnishing. By adopting a Cradle to Cradle (C2C) design guideline the product is said to reduce CO2 impact by 73 percent, waste management by 100 percent, and water use by 95 percent compared with cotton (Perella 2015). Similar products e.g. Econyl has been developed by Interface, world's largest modular carpet manufacturer, by reclaiming discarded fishing nets, by entering into a collaborative supply chain partnership with Net-Works enables local residents to collect discarded nets, and sell them back into a global supply chain for issuing a second-life (Net-works 2016).

Further, Re:newcell, as one of the pioneers in chemical cellulose based recycling of textile in Sweden, is a technology company that was founded in January 2012 by a group of researchers from KTH Royal Institute of Technology and a small investment company. The company accomplished a new ground breaking recycling process of cotton and other cellulosic textiles such as viscose into new textile fibres.

The first re:newcell production of a fully recycled garment was presented at a fashion show during the first week in July on Gotland, Sweden in 2014. The garment is a breakthrough for the textile

recycling industry. The garments shows that the production technology is fully functioning and produces comfortable clothes of high quality. The dress is made out of recycled blue jeans which were then recycled with the technology built in collaboration of re:newcell and KTH. The dress was produced in cooperation with Svenskt Konstsilke AB, Textilhögskolan in Borås and Wargön Innovation. Additionally more items have been made such as dresses, a t-shirt, a children's pyjamas and a scarf. Re:newcell's latest activities focused on building its textile recycling factory in Kristinehamn in Sweden. It is estimated to be completed by the first quarter of 2017 and have a maximum capacity of 7 000 tons per year. (renewcell 2017)

Conclusion

As a conclusion for this report, it is worth mentioning that, post-retail initiatives through multi-channel selling create possibilities for higher revenues, better corporate image and higher consumer awareness. Inter-organizational collaborative partnerships with diverse reverse value chain actors, such as sorters, remanufacturers, logistics providers, provide access to complementary resources and competences essential to generate higher specialization and product reuse. Such collaborations extend into collaborative knowledge creation, such as workplace training.

Intra-organizational key aspects such as: (i) demand-oriented sorting, (ii) resale assortment planning and communication strategies, (iii) concurrent product-process design, are crucial. Concurrent design is key to remanufacturing to support simple garment reconstructions and yet have a line production to attain process standardization through repeatability. Demand-oriented sorting made by the sorters is essential in dynamically updating their sorting parameters (e.g. depending upon types of product, fabric, colour, style, etc.) based upon market developments. However, the key challenges are in terms of: antagonistic effects of illegal actors in used clothing net-work, low degrees of trust among the actors with conflicting business motives, along with lack of process standardization (in sorting and remanufacturing).

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