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Introduction

The textile and fashion industry is resource-intensive, operates in a linear paradigm, and needs a serious overhaul to work within planetary boundaries, including moving towards circular economy. Promoting the transition to a circular and resource-efficient textile ecosystem requires cooperation and effort from all levels of actors, from industry to consumers to municipalities and EU policy. THREADs project seeks to connect textile-related actors in Northern periphery and Arctic regions, who face unique challenges in moving towards circular economy due to i.e. sparse population and long distances. In addition, challenges common to all EU countries include the increasing amount of textile waste, the fragmented nature of the textile industry and used textiles handling, and companies, NGOs and municipal actors needing to take into account changing EU legislation surrounding textiles and clothing, waste management and circular economy.

In Finland and Sweden, municipal waste management retains at the moment the responsibility to deal with textile waste from households and they are one of the key actors in the change towards circular economy.

Improving all stages of the textile circular economy, including textile waste collection, sorting, reuse, repair, and related policy development, requires decision-making that is informed by reliable data and a thorough understanding of local and national conditions. Despite the substantial volumes of textile waste generated across EU Member States, research on the composition and characteristics of textile waste remains limited. In the absence of robust data, identifying the most suitable end uses for used textiles is challenging, often resulting in inefficiencies and difficulties in coordination. To augment the current lack of data on the composition of the textile waste collected at THREADs project partner regions, two municipal waste management companies, Kiertokaari Ltd from Oulu, Finland and Luleå Miljöresurs LTD (Lumire AB), Sweden, conducted a series of studies on the composition of the textile waste collected from households in their regions.

Textile waste collection and sorting methods have developed along unique paths in project countries, shaped by local policies and circumstances. Recycling and reuse facilities and organisations (municipal and charity organisations and NGOs) participating in textile waste collection differ between the two regions participating in the textile waste composition study, despite both being located in the Arctic periphery area.

Sorting - the key to unlock textile circular economy



Figure 1 Waste Framework Directive - Environment - European Commission

Textile waste sorting, particularly when reusable textiles are to be separated from the recycling material and waste fractions, requires a remarkable amount of domain-specific knowledge. To achieve best results in accordance with the waste hierarchy as described in the EU Waste Framework Directive, sorting personnel needs to recognise not only different fibre materials, textile construction, and recycling potential, but also identify desirable brands from high fashion to hunting gear, spot fakes and ultra-fast fashion, recognise visual style features of different fashion periods and be sensitive to the changing trends in second hand fashion. In addition to this all, they should be able to figure out if a slightly defective item is repairable and if the repair is worthwhile – in short, an expert's diverse skill set. In addition to this, the job is physically demanding and there is a risk of encountering unpleasant or even dangerous contaminants. If the sorting facility is large enough, the sorting process can be arranged so that not everyone needs to have all the skills described above and workers can focus on a particular part of the

process. Communication between people with different skills in recognizing potential in discarded clothing yields the best results.

Technology such as NIR scanner and AI can assist in sorting and speed up the process, while at the same time taking away some of the more interesting and rewarding parts of the sorting job. Considering the volumes of textiles currently coming in, the sorting processes need to be made more efficient, and this requires more than manual sorting alone.

Initially, machine-based sorting using AI or similar technology would be needed. If more detailed sorting is required at a later stage, this could also be supported by technology, with human sorting as a final step where needed. This is important both because the work is highly resource-intensive and because manual sorting can also be influenced by individual judgement and personal preferences.

Machine-based sorting could also help improve the working environment in the first stages of the process to avoid employees needing to handle textiles that are heavily contaminated, dirty or otherwise unsuitable or unpleasant to handle.

Description of the textile waste composition study

Luleå Miljöresurs and Kiertokaari Ltd municipal waste companies both collect textile from citizens through multiple collection points. The composition of the end-of-life textile stream was analysed to determine the proportions of different textile categories. This baseline information will enable a comparison at the end of the project to assess whether any changes in the composition of the textile stream have occurred. Collected data is important also in complying with legislation (recycling rates, EPR), creating new economic opportunities in reuse and recycling, and in advocacy efforts to increase textile circularity locally and within the whole EU region.

Kiertokaari Ltd and Lumire LTD composition studies are not similar since the background in households' sorting instructions and end-uses of the textiles differ between these two organisations.

Kiertokaari Ltd

Kiertokaari Ltd is a waste management company primarily owned by the City of Oulu, with partial ownership by seven neighbouring municipalities. The company serves a

population of over 250,000 residents. Kiertokaari Ltd commenced textile collection activities in 2022.

The textile composition study was conducted over a five-day period in March 2025. A total of 890 kg of textiles from municipal textile collection were analysed. The objective was to establish the proportion of various categories of textiles: those that can be reused as they are, those that need to be mended before reuse, and those that can't be reused or recycled for specific reasons.



Figure 2 Textile collection roll containers with textile covers made from used jeans. Citizens can deposit used textiles in sealed plastic bags into collection containers located at various sites across the Oulu region. (Photo: Kiertokaari Ltd)

Study procedure followed the two-stage sorting procedure in use in Kiertokaari Ltd textile sorting. Citizens are instructed to put textiles in plastic bags. At the first stage of sorting a bag at a time is opened and the contents are inspected. In case harmful contaminants (mould, pests, human or animal secretions etc.) are detected, the entire bag is moved to an incineration waste container without further inspection, as the contents are all contaminated with high likelihood. Reusable objects that don't belong to textile waste and are not textiles (e.g. toys, tools etc.) are set aside for transportation to Likke recycling centre. These were not included in the study. Textiles that can't be reused or recycled for material, including rugs, duvets and pillows, were weighed separately by category. These textiles are routed to energy recovery at a local waste incineration plant.

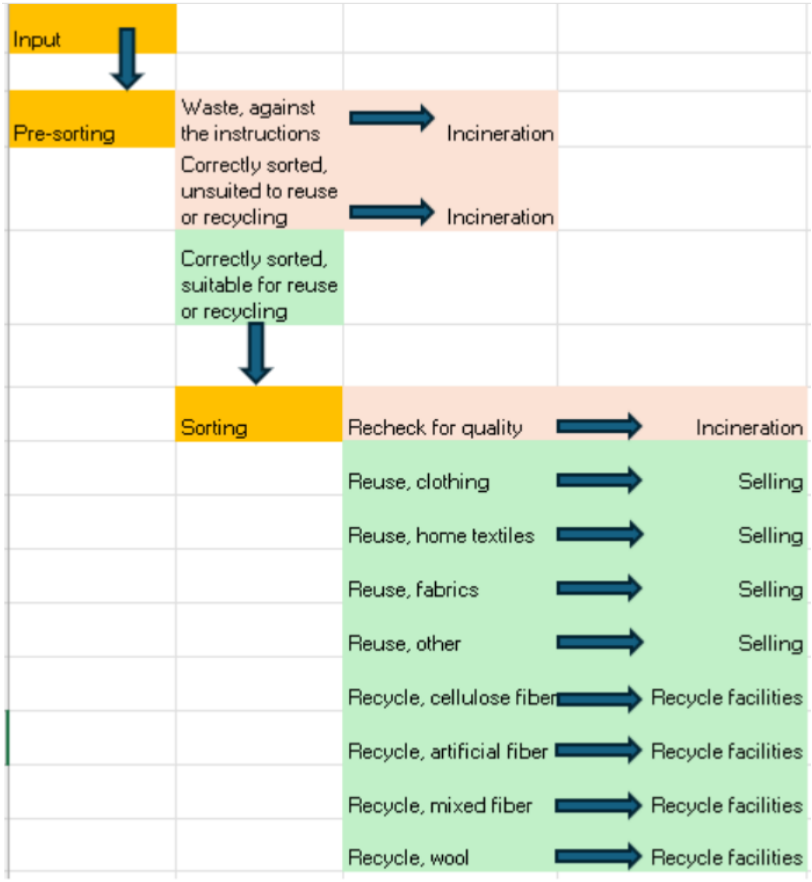


Figure 3 Process chart for regular sorting operations at Kiertokaari Ltd



Figure 4 Kiertokaari Ltd employee opening a plastic bag from textile collection point (Photo: Kiertokaari Ltd)

In the second sorting textiles were sorted into five categories;

1) Reusable as is
2) Minor faults
3) With permanent stains
4) Unwashed
5) Other reasons to discard.

Textiles with minor faults were investigated further to determine what portion of them could potentially be repaired for sale at Likke recycling centre.



Figure 5 Likke recycling centre (Photo source: Likke - Kiertokaari Ltd)

Primary sorting categories

The material stream collected from textile collection points is divided into several categories based on condition, characteristics, and material composition. To support the development of more effective circular management practices, it was necessary to gain

a better understanding of the fraction that is neither directly reusable nor suitable for material recycling. In particular, the objective was to identify the characteristics that prevent textiles from being managed at higher levels of the waste hierarchy. Based on the criteria used during sorting, seven categories were established to describe the main reasons why textiles are diverted to incineration.

Mixed waste for incineration

Objects that are not reusable are sent to incineration. During the study, objects that were not textile and not reusable were also documented. By far the most common item was a price tag from a flea market or a second-hand shop. Over 40 price tags were found in the textile stream that was inspected. This reflects the consumer aim to continue the life of their discarded or unnecessary clothes by trying to find a new owner. However, the supply of used clothes exceeds the demand, and many clothes that in theory are still in usable condition remain unsold in the second-hand market, especially if they are attempted to be resold during the wrong season (e.g. winter jacket during summer). As a last resort, these clothes are taken to textile collection. Other objects found among the clothes vary greatly, from handbags and shoes which are against donation instructions but might have been confused with acceptable items due to being dress accessories, to clearly misplaced items such as electric cords and kitchen trash.

Corporate logo wear and textiles

Textile collection is only intended for consumer use; companies should dispose of their used textiles through other channels. However, as this is impossible to enforce, a certain amount of textiles clearly originating from company use are observed in the collected textile stream. A typical example is workwear printed or embroidered with company logos. These are not sold for reuse even if they are in good condition, and are instead sent for incineration, for both security reasons and discouraging companies from disposing of their textiles through textile collection locations intended for household use.

Dirty

By far the most common type of textile that can't be reused or recycled are dirty items. Although textile collection points clearly communicate that dirty, damp, mouldy, odorous, insect-infested, or otherwise contaminated textiles, as well as textiles heavily covered in human or animal hair or stained with paint or oil, should be disposed of as

mixed waste, the proportion of textiles rejected from reuse and recycling due to contamination remains high.

There is a certain grey area: textiles that have stains that do not clean in laundry are acceptable for recycling, if the textile is washed and dried, and this may confuse citizens. As the word for stain in Finnish ("*tahra*") covers both fresh stains with residue that may come off and contaminate other textiles (e.g. greasy food remains) and "clean stains" that do not compromise recycling (e.g. permanent coffee stains), communicating this difference to citizens in an unambiguous and concise way presents difficulties. Vocabulary covering the hygienic condition of textiles in the context of reuse and recycling remains to be developed and accepted into common usage.

However, a considerable proportion of the textiles discarded to incineration due to contamination are clearly soiled and may even pose a health or safety risk. Human and animal secretions and mouldy textiles may present a health risk to the staff doing the first stage of sorting, even though at Kiertokaari Ltd sorting staff wears personal protection equipment.

Consumer research is needed to find out why citizens bring visibly dirty textiles to textile collection against instructions. It can be speculated that there are two main reasons: opportunistic and idealistic. Opportunistic refers to citizens, who do understand that heavily dirty items do not belong in textile collection, but decide to deposit them anyway due to convenience or wanting to avoid waste collection fees since the textile collection points are free and municipal mixed waste collection (i.e. the correct place for contaminated textiles) incurs a weight-based cost for the waste management customer. Idealistic refers to citizens who are averse to throwing things away for environmental or frugal reasons and hope that the municipal textile sorting will be able to find a new use for the textiles, no matter their condition. These differing motivations behind disposing of heavily soiled textiles in the municipal textile collection will require different guidance and behavioural nudges.

Glitter and sequins

After dirty textiles, textiles with glitter and sequins were the next largest category of textiles discarded at the sorting stage. Sequins and glitter are usually made of polyvinyl chloride (PVC) or polyethylene terephthalate (PET). Sequins (both sewn-on and glued) and prints with glitter may jam mechanical textile recycling machinery and introduce hard-to-remove contaminants to the recycled fibre material. Textiles decorated with glitter and sequins are also not suitable for downcycling uses such as industrial wipe applications because of reduced absorbency and risk of scratching surfaces.

Attaching sequins to clothing used to be a laborious hand process and reserved for festive and formal wear, until the invention of sequin attachments on commercial embroidery machines in the 1980s made sequin decoration faster and more affordable[1]. Technological improvements to sequin embroidery machines and fashion trends favouring shine and glitter have made sequins a popular decoration in especially women's and kids' clothing even at low price points in recent decades. Kids' indoor clothing is commonly made of 100% cotton, which is one of the fibres that have a strong market for recycling (chemical recycling, mechanical recycling for yarn, oil absorption mats, materials for the building industry, etc). If designers and clothing companies could be persuaded to avoid sequins and glitter in cotton clothing items, or invent easily removable glitter and sequins, a valuable portion of textile waste could be recovered for recycling. There exist potential solutions, such as sewing thread that dissolves when heated up to 150°C or 190°C invented by Dutch company Resortec (FAQ — Resortecs). Given the significance of this textile category, a special process to remove sequins may become viable in large sorting facilities at some point. However, this would require coordinated action from clothing manufacturers in deciding to utilize heat-dissolving

thread for sequin attachment and most likely to succeed would require regulatory measures.

Glitter prints and other plastisol prints are also popular in kids' clothing. Plastisol inks are used in screen printing, which allows for great flexibility in design, colours and special effects such as raised texture and glitter. Plastisol printing creates an elastic, thick layer



Figure 6 Sequin decoration on a children's knit. (Photo: Kiertokaari Ltd)

of print on the fabric surface which hinders recyclability. In addition to preventing mechanical recycling, plastisol prints present the tendency to develop cracks after repeat launderings, which is a common reason to discard clothing from use even if the clothing item is otherwise in usable condition. In a study by Cooper & Claxton [2] (2022) over 40% of t-shirts that were discarded and not resold had cracked prints. Screen prints in water-based ink do not prevent mechanical recycling, and neither do most other types of prints. At the moment there do not exist alternatives that allow for same diversity of special effects and achieve same kind of finishes as plastisol inks, without compromising recyclability. As the advantages of plastisol inks are significant, clothing manufacturers

are not likely to abandon plastisol inks without regulatory pressure or clearly superior technical alternatives.

Advertisement textiles

These are textiles that have been given out as promotional items or otherwise printed or



Figure 7 Detail of a cracked plastisol print. (Photo: Rinna Saramäki)

embroidered with advertisements and not made of cotton. Advertisement textiles made of cotton are sorted for recycling and are not included in this category. Advertisement textiles are sorted separately from corporate logo wear, because advertisement textiles come from households and are sorted correctly for recycling by the citizens, whereas company logo wear is incorrectly deposited to municipal textile collection points by companies. There is little interest in the second-hand market in advertisement textiles and since they are often discarded after just one use, from the resource-savings point of view it would be ideal to avoid creating this type of item altogether.

Accessories

Non-textile accessories (hats, belts, handbags, shoes) that are in usable condition are collected for transport to Likke recycling centre.

Hygiene wear

Underwear, swimwear, socks and other clothing that presents hygienic risks are removed from the textile stream during the first sorting and sent for incineration. Exception is made for these items if they are clearly never used, e.g. in unopened package or with shop hangtags. Recycling instructions at textile collection points direct citizens to sort hygiene wear to mixed waste, however these instructions are not always followed.

Laminated and multi-layered or padded textiles

Textiles with a laminated membrane (outdoor wear, rainwear etc.), with padding or filling (puff jackets etc.) or otherwise composed of several layers of different materials are either impossible or impractical to process for material recycling. Material recycling technologies or market demand for laminated textiles and textiles with wadding do not exist at the moment. The only exception is bird down, which is a valuable natural material that can be recovered for reuse and items made from recycled down are already available for consumers. During the composition study and THREADs project, separate sorting and reuse of clothing and textile items with bird down filling has been discussed as a potential development, if suitable partners are found, such as outdoor wear companies that use down in their products. There is interest in recycling down for economic, environmental and animal welfare reasons. For example, Finnish start-up Untuvia Ltd collects products containing down, such as down jackets, blankets, pillows, sleeping bags etc., both from consumers and commercial operations such as hotels, and cleans the down so that it is hygienic for reuse. Currently duvets and pillows coming to Kiertokaari Ltd textile collection are incinerated, regardless of the filling material, but recycling options for down-filled household textiles could be investigated.

Used textile stream from northern areas contains a lot of warm, multilayered winter clothing, for which there is no demand as reclaimed material. The insulating properties could potentially be useful in non-clothing uses where heat or cold insulation is needed, but the heterogenous nature of used textiles limits applications.

First sorting

	Mixed waste	Corporate logo wear	Dirty and soiled	Glitter and sequins	Advertisement textiles	Accessories	Hygiene wear	Laminated / multi-layer/wadded clothing
Kg total	16	8	288,1	45	3	19,8	40,5	24,5

Second sorting

	Unwashed	Permanent stains	Minor faults	Other reasons	Total kg
kg	19	46,5	22,5	8,5	96,5

Minor faults

The category minor faults were inspected to determine what kinds of minor; repairable issues were the most common.

Loose threads

Loose threads is the most common minor fault found in this study. During production, hanging threads at the start and end of seams and thread remains getting stuck in seams occur routinely. In the finishing stage, these threads are usually clipped, except when aiming for very low prices by cutting costs. During wear and wash, loose threads that were tangled in seams may get loose, also seams and topstitching may unravel and cause loose and hanging threads that give an untidy appearance and, in some cases, may contribute to further seam unravelling. Clipping and removing loose threads is a textile maintenance procedure well within the capabilities of most consumers, but as they decrease the attractiveness of used clothing, removing them before resale at recycling centres can be worthwhile.

In knitwear, stitches may get caught in sharp objects and pulled as a hanging loop from the main fabric, even if the thread remains unbroken. In some cases, the hanging loop can be hidden inside the garment or eased back into the line of stitches. This requires more skill and patience than clipping loose threads but may be worthwhile especially in the case of knits made from desirable materials such as wool and cashmere.

Pilling

Pilling was the next most common issue. Pilling (loose fibres getting tangled together and sticking to the textile surface) happens usually to knitwear, and is mostly a cosmetic fault, but one that spoils the appearance and desirability of clothing. Pilling is easy to remove from thick knits with a pilling remover, while it is harder to remover from thin or delicate

knits without damaging the textile itself. Pill removal may change the status of a garment from undesirable to suitable to resell, but the time spent on de-pilling and the likelihood of the garment to be resold need to be considered.



Figure 8 Detail of a cotton-polyester jersey top with minor pilling / fuzz. Even this level of pilling makes the garment unattractive for second-hand shoppers. (Photo: Rinna Saramäki)



Figure 9 A synthetic fleece pullover with noticeable pilling. (Photo: Rinna Saramäki). Other minor faults were less common, requiring repairs that call for textile repair and sewing skills (e.g. broken zipper)

Separate study of clothing with minor faults

At a later date in October 2025 a separate study was conducted to gauge the potential and time required to repair clothing with minor faults to sellable condition. Out of 93 inspected garments, 33 were decided as not being worthwhile to repair or impossible to repair. The most common reasons that made a clothing item not worthwhile or impossible to repair were elastane that lost integrity in the material mix, several holes, fabric ripped along a seam and broken or ripped linings that would require changing the entire lining. Required repairs ranged from simple (replacing a missing button, removing pilling, re-sewing an unravelled seam) to time-consuming, more complicated repairs (replacing worn-out cuffs in college tops and pants, cutting worn-out cuffs in jeans and restitching). The decision to repair a garment depends on the skills and available time of the staff present at the sorting facility. It must be noted that not all garments can be repaired, for example in the case of fabrics with elastane that has lost integrity no repair can be done. To discover material mixes and design features that render clothing unusable and unrepairable, textile waste sorting facilities present a unique source of data that has been mostly overlooked so far.

Lumire LTD

Lumire LTD (Luleå Miljöresurs Ltd), collected textiles at its recycling centres in two separate streams during 2025: clean and reusable textiles, and textile waste. The composition study was carried out during week 37, from 8 to 12 September, in Luleå. The study was based on textiles handed in at Risslan recycling centre, which is Luleå's largest recycling centre.



Figure 10 Risslan recycling centre (Photo: Markus Paasikoski)

Textiles can be handed in at four different recycling centres across the municipality, as well as at a mini recycling centre in the city centre. Lumire LTD also communicates regularly with residents through the Instagram account Samlat Secondhand. In addition, Lumire LTD uses its main Instagram account, website and other social media channels to share information, create engagement and raise interest in textile reuse, second-hand consumption, recycling and more sustainable resource use.



Figure 11 Screen shot from Samlat Secondhand Instagram account

During the process of collecting and sorting the textiles, there were follow-up meetings with dr. Anna Lidström in Borås before, during and after the sorting process. Dr. Anna Lidström, senior lecturer at the University of Borås has researched and taught to fashion design students the reuse and redesign of used garments. The purpose was to include their input on how the sorted textiles could be categorised in order to support the subsequent redesign process in the best possible way.

Approximately 1000kg of collected textiles were sorted during the composition study. Half of this amount was dirty or soiled according to the customers who brought used textiles to the collection point, which was analysed as track A. The remaining 500 kg was considered reusable (clean and not damaged) by the customers, and was analysed as track B.

The study was performed in five days. Textiles were first sorted into waste textiles (dirty and damaged), reusable textiles, and miscellaneous wrongly sorted waste (shoes, toys

etc). Next the two tracks were sorted according to material. During the last day, at dr. Anna Lidström's suggestion, cotton and polyester was sorted further into adult clothes, kids' clothes and home textiles. Sorting was timed and it was found out that sorting 80 kg of textiles takes approximately 1 hour 45 minutes by one person, i.e. one person can sort about 45 kg of textile per hour.



Figure 12 Textiles pre-sorted by textile collection point customers. (Photo: University of Borås)

Track A composition table

Track B composition table

Material	Weight	Material	Weight
Cotton > 80%	62 kg	Cotton >80 %	73 kg
Linen	3 kg	Linen	0,92 kg
Hemp and hemp blends		Hemp and hemp blends	
Silk	0,08 kg	Silk	0,24 kg
Wool	6 kg	Wool	4 kg
Viscose	9 kg	Viscose	14 kg
Modal	0,30 kg	Modal	0
Lyocell/tencel	0,22 kg	Lyocell/tencel	0,98 kg
Acetat/triacetat	0,90 kg	Acetat/triacetat	0,14 kg
Mixed natural fibre and regenerated fibre	0,32 kg	Mixed natural fibre and regenerated fibre	3 kg
Mixed natural fibre and synthetic fibre	6 kg	Mixed natural fibre and synthetic fibre	35 kg
Mixed regenerated fibre and synthetic fibre	3,54 kg	Mixed regenerated fibre and synthetic fibre	5 kg
Polyester >80%	44 kg	Polyester >80%	71 kg
Acrylic	6 kg	Acrylic	5 kg
Polyamide /nylon	4 kg	Polyamide / nylon	8 kg

Polypropen		Polypropen	
PVC		PVC	
Synthetic mixed	3 kg	Synthetic mixed	6 kg
Leather	0, 30 kg	Leather	1 kg
Fur & Down (down jackets with synthetic fabric classed as Mixed natural fibre and synthetic fibre)		Fur & Down (down jackets with synthetic fabric classed as Mixed natural fibre and synthetic fibre)	0
Multi fibre mixes	12 kg	Multi fibre mixes	19 kg
Textiles in bad condition	15 kg	Textiles in bad condition	27 kg
Shoes	2 kg	Shoes	0
Polyurethan	0,46 kg	Polyurethan	0
		Jeans/ denim	26 kg
		Mixed natural fibres	3 kg
		Sorted wrong	0,56 kg
Pre-sorted wrongly as waste by the textile collection point customers	Total 186kg	Pre-sorted correctly by the textile collection point customers	Total 302,8 kg

Pre-sorted correctly as waste by the textile collection point customers	332 kg	Pre-sorted in the wrong category by the textile collection point customers	188 kg textile waste

Cotton (80% or more) and polyester (80% or more) are the largest fractions in both tracks. In track A, the dirty and soiled track, cotton fraction comprised of adult clothing (33 kg), home textiles (20 kg) and kids' clothing (9 kg). In contrast, in track B – reusable textiles - the adult clothing comprised the largest fraction (39 kg), but kids' clothing (27 kg) was a much larger portion of the total than home textiles (7 kg). This points to both kids' clothing being disposed of by the citizens when the clothing is still in usable condition, due to kids growing out of their clothing and moving onto the next size, while home textiles have a higher likelihood of being used until they are worn out or soiled. Home textiles are a cotton-rich fraction of the used textile stream, usually with few seams, few notions, no added decorations or thick prints, and simple construction (e.g. bed linens, tablecloths). This translates to ease of material recycling, as there are less hard parts to remove and less contamination from sewing threads and other materials than in clothing. Thus, when looking for material for mechanical or chemical recycling, where cotton is a desired material with many applications, home textiles are a promising source.

Polyester was the second largest fraction in both tracks. In track A it comprised of adult clothes (30 kg), kids' clothes (8 kg) and home textiles (7 kg). In track B, reusable clothing, the portion of polyester kids' clothing is much higher than in track A, 21 kg. Adult clothes make up the largest portion of polyester clothes also in track B (44kg), while home textiles are only 3 kg. In northern areas, polyester is used in kids' clothing mainly in outdoor clothing, much less in indoor clothing.

Denim was categorized separately in track B, as it is a fraction that has a little variation in fibre composition, colour and texture, which eases material recycling.



Figure 13 Getting familiar with the process of textile sorting in Luleå

Reusable but not sellable clothes – the difficult fraction

A substantial share of collected clothing remains technically suitable for use but no longer has resale value. Managing this fraction is challenging for waste management actors, as compliance with the waste hierarchy requires that reusable garments are not prematurely diverted to material recycling or incineration.

These actors may find it difficult to find cost-effectively users for these clothes as their market value is so low it may not cover transportation and costs incurred during sorting, pricing and shelving. One strategy to avoid excessive costs and follow the waste hierarchy

is to give out the clothes for free in dedicated locations. In Luleå, garments that are not considered suitable for resale, but are not classified as waste, are sorted into free textile containers that are available to the public at Risslan recycling centre and at Returpunkt Centrum, Lumire Ltd.'s mini recycling centre in the city centre.
However, even though the clothes are free, there are not enough recipients for the volume of free textiles sorted out in Luleå. Lumire LTD works proactively to find continued use for these textiles by contacting different organisations, industry colleagues, initiatives, preschools and schools. Lumire LTD has several such collaborations, but despite this, there is still a very large volume of textiles that does not find new use. In addition to practical sorting and collaboration activities, Lumire LTD has also explored market possibilities together with other municipalities in Norrbotten.

Lumire Ltd, together with the municipalities of Boden, Kalix and Piteå, carried out a Request for Information, RFI, regarding innovative and sustainable solutions for the collection and treatment of textile waste. The RFI was sent out nationally, but no responses were received.

The purpose of the RFI was to collect information from potential actors in order to understand the opportunities available in the market and to develop a possible future procurement process. The municipalities were looking for actors that could support circular flows, reduce the amount of textile waste sent for incineration, promote reuse and material recycling, and contribute to sustainable and efficient solutions adapted to the needs of these four municipalities. The objective was to identify a long-term partner that could provide high-quality services and contribute to the municipalities' ambitions for sustainable development. The RFI was also connected to the new legal requirements that entered into force on 1 January 2025 under the EU Waste Framework Directive and the Swedish Waste Ordinance, making it mandatory to sort textile waste separately from other waste. Municipalities are responsible for the collection and treatment of textile waste from households and similar sources.

The initiative specifically focused on the textile waste fraction. Clean and reusable textiles are already managed through other channels for reuse and resale, including second-hand actors and non-profit organisations locally in the different municipalities. The RFI therefore aimed to explore solutions for the more challenging fraction: textiles that are no longer suitable for reuse but should, in line with the waste hierarchy, be managed in a more circular way than through energy recovery.

At Kiertokaari Ltd, a selection of textiles is given out for free in a separate room in the Likke recycling centre. These items are usually in good technical condition but may require minor repairs or have permanent stains that compromise the garment's aesthetic appearance without affecting its hygiene or usability.

Free rooms, where clothing with minor defects is made available to visitors, have become increasingly popular in recent years as a means of distributing unsellable but still usable clothing in Finnish recycling centres. Because the garments are offered free of charge, visitors are often willing to overlook minor defects and accept clothing requiring repair, despite being unwilling to pay for them. Pääkaupunkiseudun Kierrätyskeskus (Metropolitan Reuse Centre)[3], which operates in the Helsinki metropolitan area (Helsinki, Espoo and Vantaa), has 13 shops, most of which include free rooms. This has been a successful strategy from the point of view of dispensing collected textiles. Of all the donated items, 44% are dispensed through free rooms, in 2023 this meant over a million textile items.

Nextiili textile reuse centre in Tampere opened a free room in spring 2025, which has become popular with visitors in a short time. In autumn 2025 it was moved to bigger location with a separate entrance to serve even more visitors.[4]

There is a global market for used clothing, particularly in African countries and in Eastern Europe. However, this trade is weakly controlled, and it cannot be ensured that unsellable clothing and textiles entering the global second-hand market are effectively separated from items with commercial value and ultimately discarded in a responsible manner. Estimates of the percentage of unsellable clothes among those with sale value in the global used clothes trade differ greatly from about 40%[5] to 1-2%[6], however it is clear there is a considerable portion of unsellable clothes within used textiles exported to African countries. Therefore, it is important to process and find end-uses for unsellable textiles within the EU region, to avoid burdening the waste management systems of receiving countries with textile waste.

Pre-sorting by citizens not reliable

Citizens' ability to differentiate between resaleable and unsellable (but recyclable) textiles is inconsistent. Lumire LTD analysed 500 kg of textiles sorted by consumers as textile waste and another 500 kg of textiles sorted by consumers as reusable, and the

results indicate that consumers struggle to recognise whether used clothing has reuse potential or not. 37% of the textiles pre-sorted as waste by consumers were in fact reusable textiles and vice versa, 38% of supposedly reusable textiles were sorted as waste by professional sorting staff. Consumers are either careless or misinformed about the resources textile waste sorting centres have for cleaning and repairing clothes, so professional sorting is essential to avoid misdirecting used textiles to non-optimal end-uses.

In addition to this, a certain share of collected textiles is neither reusable nor recyclable into new materials, but heavily soiled, mouldy or otherwise unfit for further processing. These textiles should not end up in textile collection but instead be sorted by the consumers into mixed waste or incinerated waste, according to local waste management options. Sharing of best practices between textile waste collectors on educating and informing citizens on correct sorting of waste and used textiles is important. Reducing the proportion of textiles unsuitable for reuse that enter the collected textile stream is a key priority. Soiled, pest-infested, or mould-contaminated textiles can compromise the quality, value, and usability of otherwise reusable textiles through cross-contamination. As a result, even a relatively small share of contaminated items can adversely affect the overall quality of textiles collected in a collection container. These contaminants are also a work hazard for collection and sorting staff. Personal protective equipment is used to avoid contact with harmful contaminants during sorting, but encountering heavily soiled textiles remains unpleasant and requires additional clean-up efforts to maintain hygiene.

The inability of citizens to tell apart reusable and recyclable textiles underlines the importance of skilled sorting and the need to keep developing sorting procedures to keep up with the textile waste volumes. More effort into informing consumers may lead to less work in the sorting stage, but it remains to be established what is the ideal amount of citizen-facing communication so that maximum practical reach and message penetration is achieved, but “information fatigue” is avoided.

Communicating to citizens

There is a need for common vocabulary, for example how to differentiate between stains that lead to item being incinerated, like oil stains and unhygienic stains, and stains that are not a problem in recycling – “clean” stains, such as permanent coffee stains.

Both Lumire Ltd and Kiertokaari Ltd use the same pictogram from the Nordic Recycling Symbols in their textile collection boxes, but the intended meaning is slightly different. These pictograms were first developed in Denmark in 2016 and were later expanded and adopted for use in Norway, Sweden and Finland for signage at recycling centres. They can

be used free of charge and are designed to make sorting easier for residents and to create recognition regardless of location in the Nordic region[7]. At Kiertokaari Ltd, this pictogram is used to denote damaged but clean textiles, that can be recycled as material or downcycled for various uses. At Lumire AB, the same ideogram is used to refer to textile waste, including soiled items which at Kiertokaari Ltd would be sorted for incineration together with mixed waste.



Figure 14 A selection of Nordic Recycling Symbols, the symbol used by both Lumire Ltd and Kiertokaari Ltd with some slight differences

In addition to this, Lumire Ltd has developed campaigns, courses, workshops and evening events to encourage more sustainable behaviour. One example is the campaign "Är du pyroman?" ("Are you a pyromaniac?"), which is a broader communication initiative aimed at reducing residual waste, increasing reuse and recycling, and helping materials move higher up the waste hierarchy.

The campaign can be viewed here: Börja brinna för att återvinna! - Luleå Miljöresurs AB

Poistotekstiili: A Finnish attempt to clarify textile circularity vocabulary

During Telaketju project series 2018-2025, textile waste management actors, including municipal waste companies, social enterprises dealing with used textiles, and research organisations decided to adopt term "*poistotekstiili*" to mean any textiles removed from household use[8]. The description was "textiles that are no longer needed by their owner, and include both usable, reusable textiles and textile waste, i.e. textiles that have been discarded."[9] This was intended to ease communication with citizens when instructing them on correct pre-sorting. This term is now in common use especially in textile waste related information presented to citizens in various regions on Finland. However, the meaning has drifted: in many cases "*poistotekstiili*" now refers to textiles that are broken and not usable as is, but also not contaminated. This highlights the need for terminology that clearly distinguishes recyclable but non-reusable textiles from contaminated textiles that can only be treated as mixed waste. It also demonstrates the challenges associated with identifying future information needs in advance. Going forward, a harmonised textile circularity vocabulary should be developed to cover all relevant use cases, be understandable to the public, and provide sufficient precision for textile waste management across European Union countries.

Conclusions

The composition studies conducted at Kiertokaari Ltd and Lumire Ltd yield valuable insights on how to develop the entire textile value chain towards resource-efficiency and circular economy. This requires actions and co-operation from all participants.

Overall, Lumire Ltd.'s and Kiertokaari Ltd.'s work shows that textile circularity is not only a question of providing collection points. It also requires sorting capacity, knowledge of textile quality and reuse potential, collaboration with reuse actors, dialogue with research partners, communication with citizens, and market development for textile waste treatment. The experience from Luleå also shows that even when textiles still have use value, it can be difficult to find recipients for the volumes collected. This underlines the need for new solutions, stronger markets, improved sorting methods and continued collaboration between municipalities, research actors, reuse organisations and industry.

Municipal waste management

Misplaced items, contaminated textiles and incorrectly sorted textiles are a major challenge at textile waste sorting facilities. To communicate effectively with citizens on how to pre-sort discarded textiles, municipal waste management actors need research

on the effectiveness of various methods of communication and information dissemination. Best methods should be shared between regions and countries.

National guidelines on textile waste pre-sorting in households differ, which makes cross-border cooperation difficult at the moment. Harmonizing composition study guidelines will make comparing results and estimating potential for industrial textile recycling in the Nordic region more efficient.

The Nordic signage for recycling is a promising example of co-operation between the Nordic countries and waste management organisations. A potential future project might be to develop this set of ideograms for textile waste and used textiles collection with uniform meaning across all EU countries. This should be done through a series of stakeholder consultations to ensure citizens understand these ideograms as intended and that they cover all the use cases.

Textile and fashion industry

The textile and fashion industry should co-operate with waste management to gather data on what features in textiles and clothing hinder or facilitate re-use and recycling. This data should then be considered when designing and producing new home textiles and clothing. For example, it is evident from the composition study done at Kiertokaari Ltd that glitter and sequins present a problem in textile waste management, and steer otherwise recyclable or reusable clothing to energy recovery – a much lower rung on the waste hierarchy. Therefore, it would be ideal to avoid using glitter and sequin decorations on items that are generally used for a fairly short time before being worn out, as in the case of children's clothing. If the industry is serious about circular economy, it should take these issues into account when producing clothing and reach out to textile waste management actors to gather data on the durability of materials and construction, and how to avoid features that shorten the actual service life of different garments.

Going forward, the digital product passport (DPP) will make both sorting and routing used garments and household textiles to the most suitable end use and data collection simpler and faster.

EU policies

Ecodesign for sustainable products regulation could at future revisions include minimum, medium and maximum intervention as a framework and guiding principle for each textile product, so that certain products could be designed with effortless material recycling in mind (e.g. monomaterial products, avoiding design features that complicate recycling such as sequins), while others could be designed with the intention to maximize

product lifetime and promote repair and reuse, while sacrificing recyclability. This could be indicated in the digital product passport.

Regulatory decisions and legislative changes that are not fully thought through can create confusion and, unfortunately, also a certain level of frustration among citizens.

Citizens

If we want people to extend the life of textiles and make more materials circulate, information alone is not enough. In today's society, where people are overwhelmed by an excess of information, it's necessary to break through the noise in order to reach them. To achieve positive change, it's necessary to find ways to engage citizens without exhausting them. We need to bring people along with us — not only those who are already interested and informed, but the general public.

Comparisons to other textile waste related projects

As a part of project *"Arjen kiertotaloudesta kasvua ja hyvinvointia Rovaniemelle"* (Growth and wellbeing in Rovaniemi through everyday circular economy), a two-month study was conducted on the textile waste flows at Rovaniemi municipal waste management company Residuum. Textile waste was recognised as a key area in improving material circularity in Rovaniemi area. 72% of the collected textiles could not be reused or used as material and were sent for energy recovery at a local incineration plant. Reuseable textiles were sold in Likke recycling centre in Oulu (Kiertokaari Ltd), and textiles reusable as material were sent to Rester Oy in Paimio. Since transport costs are high compared to the value of collected used textiles, it was discovered that local reuse and recycling options would be preferable. In addition, sorting and preparing collected textiles for reuse could create jobs especially for vulnerable and hard to employ groups.

During the project, potential local reuse and recycling partners were mapped and contacted. Car repair shops, shipyards and educational institutions were recognised as potential locations for utilizing used textiles. Many of the contacted potential reuse partners were interested in using used textiles in their operations, however these end-uses need to be considered already at the sorting stage to sort the textile flow into fractions according to the end-uses (e.g. Terrycloth towels are useful for cleaning and oil absorption in car repair shops but would need to be sorted separately for convenience already in early stages of sorting). A local second-hand shop conducted a pilot run of selling reusable clothing sorted from the used textiles flow, with modest success.

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