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Sorting Textiles Out: Developing Better Practices

A Product Oriented Thesis Developed in Collaboration with NewRetex and the EU Interreg SorTex Project

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Abstract

This master's thesis investigates how the collection and pre-sorting of textile waste can be improved through Design Anthropological methods, with a focus on reducing the amount of wet and contaminated textiles, increasing reuse and recyclability rates, and addressing social and material challenges across municipal contexts. Conducted in collaboration with NewRetex and as part of the Interreg-funded SorTex project, the study combines design methods and ethnographic fieldwork - participatory observations, situational conversations, and semi-structured interviews, with data and quantitative correlation analysis of municipal textile waste from NewRetex's data traceability system. Drawing on Shove's Dynamics of Social Practice Theory and Bowker and Star's theory of classification from the book "Sorting Things Out: Classifications and Its Consequences", the study maps the socio-material dynamics shaping textile waste practices by uncovering how meaning, competence, and material design affect the quality of textile waste. In addition, the thesis critically explores how standardised classification systems create tensions with local material realities, and how practices and classifications are shaped and re-shaped through framing and citizens' meaning perception, proving the desire to implement consistent, streamlined practices to be contradictory and counteractive.

Introductory in the analysis and testing of collection methods for textile waste, the thesis presents a problem exploration and mapping, focusing on the industrial, process and material barriers in textile waste management. In regard to the material design of the collection methods, the correlation analysis showed that 660L and 20-foot shipping containers have a low sensitivity to rain, indicating the amount of wet is influenced by social practice, and that containers with side gates are highly sensitive to rain on a material level, but is still capable of producing low water exposure, due to social practice. The final section of the paper synthesises insights from all parts of the research, presenting a step-by-step guide of what has worked well in certain contexts by combining quantitative analysis with field insights. The master's thesis has produced two physical products, in the shape of prototype signs developed and tested with municipalities as part of the SorTex project. They were designed to influence the formation of a proto-practice, enhancing the meaning element of the sorting practice and creating engagement by making it easier to understand the journey of textile waste and why correct sorting matters. The thesis does not conclude with a final, fixed method, but instead highlights that because practices are dynamic, the system has to be iterative and ready for re-design. Future collection methods for textile waste are based on interventions and designing in ways that respond to actual practices, rather than forcing ideal solutions.

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Introduction

Sorting Textiles Out: Developing Better Practices is a product-oriented thesis developed in collaboration with the textile sorting and recycling company NewRetex, as part of the EU Interreg-funded project SorTex, where NewRetex is a partner. The thesis title references the book "Sorting Things Out: Classification and Its Consequences", reflecting the conceptual foundation of classification and the SorTex (Sorting Textiles) project's focus on textile waste management and sorting. This collaboration serves as NewRetex's contribution to the SorTex project, with this thesis fulfilling their project obligations for Work Package 3. SorTex is a practical demonstration project that translates research-based principles into concrete solutions and local implementation (SorTex, 2024). From 2025, the EU Waste Framework Directive makes it mandatory for the member states within the European Union to separately collect textile waste. In Denmark and Sweden, the responsibility for the collection and management of textile waste is placed on the municipalities. SorTex is a Danish-Swedish collaboration project initiated to examine and develop solutions for a best practice method book for municipalities to collect and manage the significant amounts of textile waste. The objective of the project is to ensure that textile waste is sorted effectively, following the Waste Framework Directive, so that it is reused, recycled and can continue to create value in new circular business models. The project includes 13 partners across the two governments and cross-fields, ensuring collaboration between public and private organisations across the entire value chain for textile waste, from collection to pre-sorting, to reuse and recycling. Collaboration and co-creation are the main factors of the project, allowing the combination of technologies and capabilities to be shared across regions, which is fundamental to approaching the international challenges caused by textile waste. It is a wicked problem that cannot be solved in isolation. The desired end-value for SorTex is a higher collection rate and an improved, efficient pre-sorting of textile waste, manageable by the municipalities, that leads to a reduction in textiles ending up in incineration and landfills.

NewRetex stands for "New Recycled Textiles" and is a sorting and recycling company, working with textile waste in Denmark. They receive and handle textile waste, primarily from municipalities and take-back solutions from brands. NewRetex has designed Denmark's first full-scale automated sorting facility, built with artificial intelligence, NIR sensors and X-rays to sort textiles into different fibre sorts and colours (NewRetex, 2025). Before the textile waste enters the automated sorting line, the incoming textile waste is manually pre-sorted. The textiles eligible for recycling then go into the automated sorting machine, which can read the material composition and colour.

When the textiles are sorted, they are sent to either mechanical or chemical recycling based on the material composition or downcycled. In addition, NewRetex has an innovative data system, ensuring full traceability, called a MES (Manufacturing Execution System). Each delivery, called a batch, has its unique QR code and a LOT number that follows the batch through the process. In the pre-sorting, the conveyor belt that receives the textile waste and the containers for the wet, dirty and other waste fractions are all placed on weights, so the exact amount of each fraction is documented through the MES.

The SorTex project spans from 2024 to 2027 and is divided across 6 “work packages”. The project, and its work packages, are organised into four focus areas: analysis and testing of collection methods, analysis and testing of pre-sorting, development of business models and development of strategy recommendations (SorTex, 2024). NewRetex is a supportive partner in analysing and testing collection methods using their MES system as data support, with this thesis representing the fulfilment of Work Package 3

Work Package 1	Project management and communication
Work Package 2	Mapping of ecosystems and actors
Work Package 3	Collection of textile waste
Work Package 4	Pre-sorting of textile waste
Work Package 5	Utilisation of textiles – business models
Work Package 6	Consecutive value chains developed in collaboration

Figure 1: Overview of Work Packages

Desired end-value and Thesis Question

The main objective of Work Package 3 is to analyse and test collection methods to develop a practical method book for effective and appropriate textile waste collection in Northern Europe. The method book is expected to contain collection methods adaptable to varying geographical condition as bigger or smaller cities, and to different housing types, e.g. houses or apartment buildings (SorTex, 2024).

Therefore, my primary thesis question is: How might I design collection methods that improve the reuse and recyclability rates while reducing wetness across diverse municipal contexts? While also addressing how the interplay between material design (containers and collection infrastructure) and social practice (citizen behaviour and collection worker routines) impacts the level of wetness and contamination.

Background: From Waste to Resource

The fashion and textile industry is consistently ranked among the world's top five polluting sectors due to its extensive resource demands, high production and consumption volumes and waste generation. Central to this environmental burden is the industry's massive output. According to Textile Exchange, in 2023, global fibre production reached a record 124 million tonnes, a 7% increase from the previous year, and it is projected to grow to 160 million tonnes by 2030 if current trends persist (TextileExchange, 2024). Globally, between 80 and 150 billion garments are produced annually - a volume fuelled by fast fashion brands like SHEIN, which heavily rely on virgin fossil-based synthetic fibres to mass-produce low-cost clothing at unprecedented speed. While the production phase of the synthetic fibre is resource-intensive, the use phase is equally as polluting. Fibres like polyester shed microplastics during washing, which contributes to ocean pollution, with about 35% of microplastics in the ocean originating from synthetic textiles. The European Union states that: "A single laundry load of polyester clothes can discharge 700,000 microplastic fibres that can end up in the food chain" (EU, 2024).

In addition, the sector is responsible for approximately 10% of global carbon emissions, which exceeds the combined emissions of international flights and maritime shipping (Maiti, 2025). The sector is the second-largest consumer of water, contributing to 20% of industrial water pollution through textile dying, and uses 79 trillion litres of water annually, with one single cotton t-shirt requiring about 2.700 litres of water to produce, equivalent to the drinking needs of one person for

2.5 years (UN, 2025). In the EU, the average consumer purchases around 16 kilograms of textiles per ye - often poorly used and quickly discarded, especially within fast fashion models that encourage constant consumption. With so many garments entering circulation, the volume of textile waste is growing rapidly (EU, 2024). On a global scale, the textile industry contributes to the creation of 92 million tonnes of textile waste yearly, numbers based on highly uncertain data due to the high complexity of the supply chains in the industry, so the numbers could be much higher. SorTex claims that approximately 7.5 megatons of textile waste are produced yearly within the EU, of which 360.000 tonnes come from the Nordics (SorTex, 2025).

Waste Framework Directive

The Waste Framework Directive, as portrayed in Figure 2, is a directive that: “sets the basic concepts and definitions related to waste management, including definitions of waste, recycling and recovery” (EU, 2025). The WFD presents fundamental waste management principles, prioritising the prevention of waste. The principles include the requirements of handling waste in ways that ensures no harm to the environment and human health, that does not cause risks to animals, soil, plants, water and air, no noise and odours as nuisances.

Figure 2: Waste Framework Directive. Taken from EU's website

Extended Producer Responsibility

The Extended Producer Responsibility Directive (EPR) is an EU regulation requiring textile manufacturers to take financial responsibility for the waste they generate, its collection and processing. As of writing, there is no final consensus on what this responsibility entails (EU, 2025). A press release from the European Commission on 19 February 2025 states that manufacturers must reimburse costs for collection, sorting, and recycling, implying full coverage, not a dynamic fee. However, it also mentions that fees will vary based on a product’s environmental impact, circularity, and sustainable design, including weight, quantity, and compliance with the Eco-design for Sustainable Products Regulation or similar legislation. Criteria such as product durability and lifetime are included, though definitions and methodologies are yet to be clarified. While the

approval timeline is uncertain, the directive is unlikely to be enforced before 2028. The rules apply to textiles including clothing, accessories, hats, footwear, bed linen, curtains, and blankets.

Methodology

There are various classifications and practices associated with textile waste from the dumping of clothes, to sorting and the recycling process - from citizens and their behavioural patterns to the patterns of professionals. Therefore, I have included two main theories to support my research and development of my master's thesis. The first theory relates to the practice and impact of classification from the book "Sorting Things Out" by Geoffrey Bowker and Susan Star (Bowker & Star, 2000). To support my investigation into the practices of textile waste management and to design for better practices, the second theory is The Dynamics of Social Practice - Making and Breaking Links by Elisabeth Shove (Shove, Pantzar, & Watson, 2012). I am using design anthropology as a method to ethnographically discover, map and analyse the classifications and practices and to develop possible new ones. The Design Anthropological methods and my fieldwork will be presented at the end of the research-design section. My thesis will likewise draw on findings from one of my previous studies: A Design Anthropological Study of Textile Waste Management in Denmark: A Consumer Perspective. My anthropological study was conducted as part of the course "Design Anthropology" in the winter of 2023, and has laid the foundation for my continued interest in the field and its challenges, this time focusing on a systematic perspective. Therefore, I will be drawing on and supplementing with my findings related to the citizens' perceptions and practices (consumer behaviour) related to textile waste handling.

The outline of my analysis follows the classical phases of a design process, beginning with an exploration of the current practices followed by a problem exploration phase, idea generation and prototyping, and lastly the development phase. As my thesis has been written as part of a company collaboration, I have chosen to write it as a reflective, critical report of my design process and experiences.

Classifications – Sorting Things Out

Informal	Local	Standardised	Globalised
• Spontaneous, situational, and context-dependent. (ad hoc) • Created on-the-go, often without codified rules. • Reflect common sense rather than institutional standards. • Inconsistent	• Developed within specific communities, professions, or social contexts • They often clash with global standards because they reflect different values or needs • May be invisible to outsiders of the context	• Structured, rule-governed systems of classifications • Explicit and systematic • Used in institutions, healthcare and government forms	• Broad application across different contexts — often driven by institutions, governments, or global organisations • Aimed at interoperability, consistency, and scalability • Tend to flatten local variation

Figure 3: Types of Classifications

In their book, Bowker and Star establish how classifications actively shape behaviour, systems and possibilities. At their core, classifications are systems of categories used to make sense of complex realities. They are tools for organising knowledge, practices and people. Once classifications are embedded into systems they are normalised and often become invisible until challenged by new classifications and “changing such categories, once designated, is usually a cumbersome, bureaucratically fraught process” (Bowker & Star, 2000, s. 3). Furthermore, they are historically and culturally situated reflecting specific values, moments and power structures. When something is "classified", it is also defined as what it is not, which shapes how it is treated - classifications are not simply reflections of reality; they co-construct it. Sorting Things Out distinguishes between 4 different types of classifications presented in Figure 3. In my analysis, I incorporate the different classifications to critically examine how textile waste is understood, handled and regulated across different actors, and as an analytical framework for identifying classification tensions. By mapping how textile waste moves across classifications – and where they break down – I present how misalignments between classification types can result in confusion, non-compliance and lost material value. Furthermore, in addition to being an analytical lens, I use Bowker and Star to challenge and expose classification systems in action, through e.g. design interventions, and as a foundation for design reasoning, to understand where classification systems fail, and how design can support their realignment to better reflect material realities, stakeholder needs and sustainability goals.

Dynamics of Social Practices

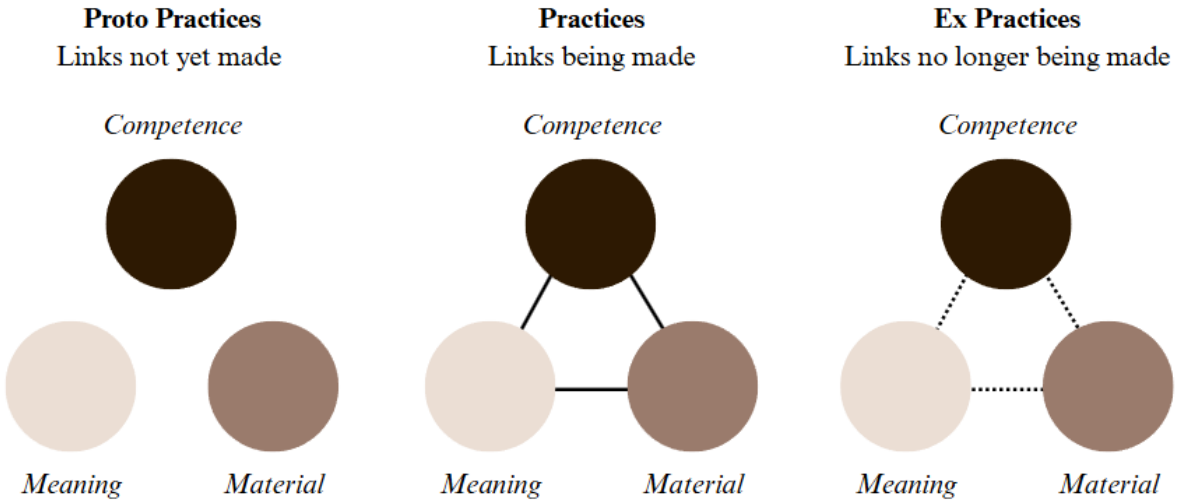


Figure 4: Shove's Dynamics of Social Practices

According to Shove "social practices consist of elements that are integrated when practices are enacted", identifying meaning, competence and material as the defining elements that make or break a practice (Shove, Pantzar, & Watson, 2012, s. 2). Practices are not isolated behaviours but dynamic configurations that evolve as these elements shift. Meaning refers to the symbolic significance and social interpretations attached to a practice; competence encompasses the know-how and practical knowledge required to carry it out, and material covers the physical objects, infrastructures, or resources involved. Shove draws on German sociologist, Reckwitz, definition of practices as "interdependencies between forms of bodily activities, forms of mental activities, things, and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Shove, Pantzar, & Watson, 2012, s. 2). In addition, Shove differentiates between proto-practices as emerging arrangements of the three elements that are not yet widespread or stabilised but show potential to become routinised; practices that are established patterns of action and ex-practices that were previously widespread but have been disintegrated due to the loss of one or more core elements.

I use Shove's model as both an analytical tool and a design lens to identify disruptions in existing textile waste practices and to guide interventions that realign meaning, competence and material elements. By modifying container infrastructure, training and communication tools, my research seeks to co-create conditions for a sustainable proto practice to emerge.

Research Design

The purpose of this section is to outline the overall structure of my study and to explain my approach to researching, testing, and lastly developing my design ideas and solutions. My research framework consists primarily of primary research, supported by secondary sources from desk research. Furthermore, it consists of a mixed-methods framework, using quantitative data to support my qualitative findings. My study follows a design practice-based research design, incorporating iterative prototyping, user-testing and design anthropological methods such as participatory observations, semi-structured interviews and loose conversation. My research approach follows Kees Dorst's notion of abduction-2 for design reasoning, where the only known is the desired end-value, the "what" and "how" are part of the investigation process (Dorst, 2011).

Quantitative data

My quantitative research primarily consists of data from NewRetex's MES system. As mentioned, NewRetex has data on all their received batches from the municipalities and other collaborators, going through the whole sorting process. The data is extracted in the form of a PDF report either for each batch or for the quarter with multiple batches. The engineer at NewRetex helped me extract the raw data in an Excel file from all the batches from the different municipalities, dating back to the start of the system in June 2024. This method helped me form an overview of the average level of the wet, dirty and other waste fractions for each municipality by looking at the batch level, the area and what month it was collected. So, instead of looking into each individual report, I formatted a list sorted by all the municipalities and with the data for each batch in one file. Compared with my fieldwork, looking into the different collection methods and practices utilised by the municipalities, the formatting of the data from the MES, helps me map the correlation between the material design of containers and collection methods with the worst- and best-case scenarios based on the data. In addition, I have investigated the amount of rain for each period matching the batches and the area of the municipality using data from the Danish Meteorological Institute (DMI), to analyse the correlation between the number of wet textiles with both container and collection methods and the amount of rain received in the period (DMI, 2025).

Design Anthropology

According to Otto and Smith, anthropology is the "comparative study of societies and cultures, based on detailed empirical research in concrete social contexts" (Otto & Smith, 2013). Ethnographic fieldwork is the main element in anthropology, with participatory observation being a key method. Ethnography involves immersing oneself in social life to grasp and convey its complexities. Traditional anthropology seeks to deepen the understanding of existing social realities, describing the world as it is. In contrast, Design Anthropology is action and future-oriented, seeking to create change by developing systems, services, products or interventions based on the fieldwork (Drazin, 2020). The fieldwork is shaped by a design agenda – such as improving textile waste practices – which guides the inquiry. Keith M. Murphy defines design anthropology as a hybrid approach combining ethnographic inquiry and design practice to explore and intervene in complex social worlds (Murphy, 2016). It is more than just using ethnographic tools to inform design - it is a collaborative and generative practice that sees both design and anthropology as mutually constitutive modes of knowledge production. Murphy notes that in Design Anthropology "a shared set of interests in material culture, human behaviour and social values encourages anthropologists to collaborate with designers on projects blending creative skills with an anthropological sensitivity to people's lived experiences" (Murphy, 2016).

My ethnographic fieldwork consists of participatory observations, semi-structured interviews, situational conversations, design interventions and prototyping. Participatory observation, as described by Mogensen and Dalgaard, is about actively engaging in the practices the researcher wish to study. My 4-month collaboration with NewRetex served as an extended participatory observation, engaging in the everyday activities, the business operation, with a specialised focus on the internal and external processes related to textile waste. I became part of the context to gain a deeper understanding of the practices related, e.g. sorting, classifications, communication with municipalities and transport companies, and the materiality of the container types, as they unfold. Being present allows me as the researcher to build trust, access informal knowledge, and notice subtle dynamics that structured methods might overlook, enabling richer insights (Mogensen & Dalsgaard, 2018). Situational conversations, which occur naturally in contexts and allow for open-ended insights, took place daily during my fieldwork at NewRetex. These informal exchanges became a key data source, especially since I had consistent access to core employees and other events (see Figure 5), allowing me to develop a sense of the environment while uncovering key themes and

potential questions relevant to my research focus. In contrast, semi-structured interviews are "formal exchanges of words where the ethnographer steers the conversation to pinpoint identified questions and themes" (Rytter, 2018). A design intervention uses a designed object, system, process or experience to explore, provoke, test and influence change, getting immediate reactions by intervening in the status quo (Dorst, 2011). Lastly, prototyping helps with visualisation and testing and can therefore act as a tool for further research, as Tschimmel explains how: "designers usually apply sketches, drawings and material models to explore the project problem and solution together" (Tschimmel, 2012). As I have used Design Anthropology as one part of a mixed method, to support and expand quantitative data from NewRetex, I will not present my fieldwork and findings independently, instead presenting it with situations and quotes throughout the analysis where relevant, to support the data.

For the sake of reading ease and anonymity, I have decided to name the test municipalities - the selected municipalities/customers at NewRetex - Test Municipality 1, 2, 3, 4, and 5. For the external municipalities and waste management organisations that I contacted outside of the SorTex project, I will be referring to them as “WMOs”.

Method	Description
Participatory Observations	4 months working with NewRetex, being physically present daily at the office and participating in the daily operations, internal and external processes.
	Participating in the activity, pre-sorting, at NewRetex for a full batch (8 hours, 2 tons).
	Participating in 15 SorTex work package meetings.
	Participating in a 2 day-long conference, with SorTex (events)
	Participating in an 8 hour conference with Dakofa.
	Participatory observations at 2 recycling stations
	Participating in EPR system brainstorms
Semi-structured Interviews	4 interviews with test municipalities/WMOs
	1 interview with a WMO outside the project
	1 interview with the founder of NewRetex
Situational Conversations	Employees at NewRetex (4 month duration)
	Phone calls with 6 WMOs (outside the project)
	Participants at the conferences (e.g., municipalities and WMOs outside the project)
	The Swedish partners of SorTex
	Employees at the Danish Environmental Protection Agency
	The Danish Minister for Environment
Design Intervention	Sent out a request for the right of access to documents, to 13 of the biggest WMOs in Denmark - any documents regarding the handling of textile waste throughout the value chain
	Conducted 5 "training tours" for the collection workers from 1 test municipality, together with the tender coordinator at NewRetex, to enhance the competence and meaning level of textile waste
Prototyping	Designed two visual prototypes to test assumptions and invoke potential changes in textile waste practices

Figure 5: Fieldwork Overview

Designing Towards Better Practices

Mapping Textile Waste Practices

The objective of the following section - and the first aspect of my research - is to provide an analytical overview of the current methods for textile collection and management in Denmark with a specialised focus on establishing the problem fractions in the different tiers of the value stream through visual mapping. Understanding the current practices within socio-material relations before creating alternative processes is central to Design Anthropology, ethnographic fieldwork and Design Practice, which I have used to guide my research (Murphy, 2016. Accurate framing of the current practices, including problem framing, is essential for the design process and for designing prototypes with purpose, testing in context and refining based on feedback (Cross, 2006. Furthermore, before and during my fieldwork, conducting participatory observations, loose conversations and semi-structured interviews with different actors within the Danish textile waste industry, I found no clear, holistic mapping, of current practices for either business or consumer purposes. As I began my research, I experienced a lack of shared knowledge and transparency across actors in the industry. The mapping is based on my conducted study presented in Figure 5 which I performed from January to May 2025 as part of my collaboration with NewRetex, and consists of a distinct mapping for each current collection method. Visual and conceptual mapping are key tools in the design process's explorative phase. They help designers identify, visualise, and understand challenges in a structured yet creative way, enabling simultaneous exploration of problems and solutions (Tschimmel, 2012.

In Denmark, textile collection follows a formal “2-stream solution”, a standardised classification system that separates used textiles into two categories: “reuse/second-hand” and “textile waste,” which guides municipal and organisational handling practices (Bowker & Star, 2000). Since July 1st, 2023, Danish municipalities have been responsible for managing the “textile waste” fraction thus embedding the classification within regulatory and infrastructural systems (Miljøstyrelsen, 2025). The “reuse” category, in contrast, remains the domain of NGOs such as the Red Cross, Blue Cross, Salvation Army, and Save the Children. These organisations operate with what Bowker and Star would describe as a local or community-based classification system—rooted in practical, everyday decision-making about what is sellable or donatable. While these NGOs may choose to align their practices

with broader reuse objectives, their classification methods are often implicit and situational, shaped by informal standards of quality, wearability, and market demand. As Bowker and Star emphasise, such classifications are not neutral—they carry consequences for how materials are handled, valued, and made visible within policy, logistics, and everyday sorting labour (Bowker & Star, 2000). The Danish Government has established a standardised classification system for collecting textile waste as part of a broader policy to streamline household waste management. According to the "Climate Plan for a Green Waste Sector and Circular Economy" from 2020, the Danish Environmental Protection Agency (DEPA) declared that the collection of the Danish population's waste must be homogeneous and streamlined within the now 10 waste fractions (Munkholm, Christensen, & Christensen, 2023). Furthermore, it was declared that the collection must be performed near households and consider different household types.

Based on my review of reports by the DEPA and insights from the Dakofa conference, it is evident that the design tool of framing has shaped the development of textile waste management practices. According to Kees Dorst, framing in design is used to quicken the creative problem-solving process by applying "frames" or learnings that the designer has faced from similar problem situations (Dorst, 2011). In practice, this means that the DEPA have framed the textile waste system using methods and practices already established for the nine other waste fractions, as e.g, the same material design of containers and trucks for collection. At the Dakofa conference, a representative from the DEPA provided insights into this decision, stating that the citizens did not want additional containers or to switch out containers again - and that collection workers should be able to handle the textile waste based on existing practices and solutions. Therefore, the practice for the seperate collection of textile waste follows the existing standardised collection methods; pick-up arrangements, that has to be near-homes and in public, and deposits at recycling stations. Based on my design anthropological fieldwork and desk research, I identified a need for a more dynamic and in-depth classification system. While overall classifications are defined at a national level by the DEPA, municipalities determine the specific mix of collection methods and container types used locally. As these local variables directly influence the quality and rate of recycling and reuse, I developed more “localised classifications” to capture variations in container type, household context, and collection method. Both the project plan for SorTex and the declaration from the Danish Government state the need to consider different household types, so my mapping distinguishes between collection at houses, apartment buildings and public areas.

As well as the responsibility for the collection of the waste fractions, municipalities have the responsibility for the further handling. As per the Danish Public Procurement Act, the municipality must ensure the best possible use of public funds through effective competition and publicly put the

expected amount of waste on tender for Danish waste facilities to make their offers (Retsinformation, 2025). This is due to the Danish Waste Proclamation stating that municipalities can not sort and handle waste internally, as they need to ensure the competitive position for waste facilities in the industry. In this process, the municipalities, however, have a significant impact on who wins the tender, as they have to develop tender documents with specification requirements. Through my fieldwork, the design intervention described in Figure 5, I received 4 examples on municipal tender documents with specification requirements. Specification requirements are formed by the WMOs, as it fulfils their responsibility to ensure the proper sorting and management of textile waste after collection, and it forms the basis of who can win their tenders. According to the tender coordinator from NewRetex, the contents of the specification requirements vary from WMO to WMO, however the general overview of requirements based on the 4 examples I received was requirements of: “The quality of textile waste”, “delivery of textile waste”, “sorting and handling of textile waste” and “reporting”.

Methods for House Collection

Through my fieldwork, I have mapped three sub-methods for textile waste collection for pick-up schemes at houses. My first major finding from my desk research was that a more in-depth investigation and analysis were needed to map the material practice of the different methods. As it is the individual municipality's responsibility to establish the collection method for textile waste, based on the standardised recommendations from the DEPA, I found limited information on the various websites regarding waste management, as a majority referred to the type of container used, but not the practice around it. Therefore, as mentioned, I chose to request the right of access to relevant documentation from the WMOs, followed by visits (participatory observations) and semi-structured interviews with the test municipalities partaking in the SorTex Project to establish my mapping.

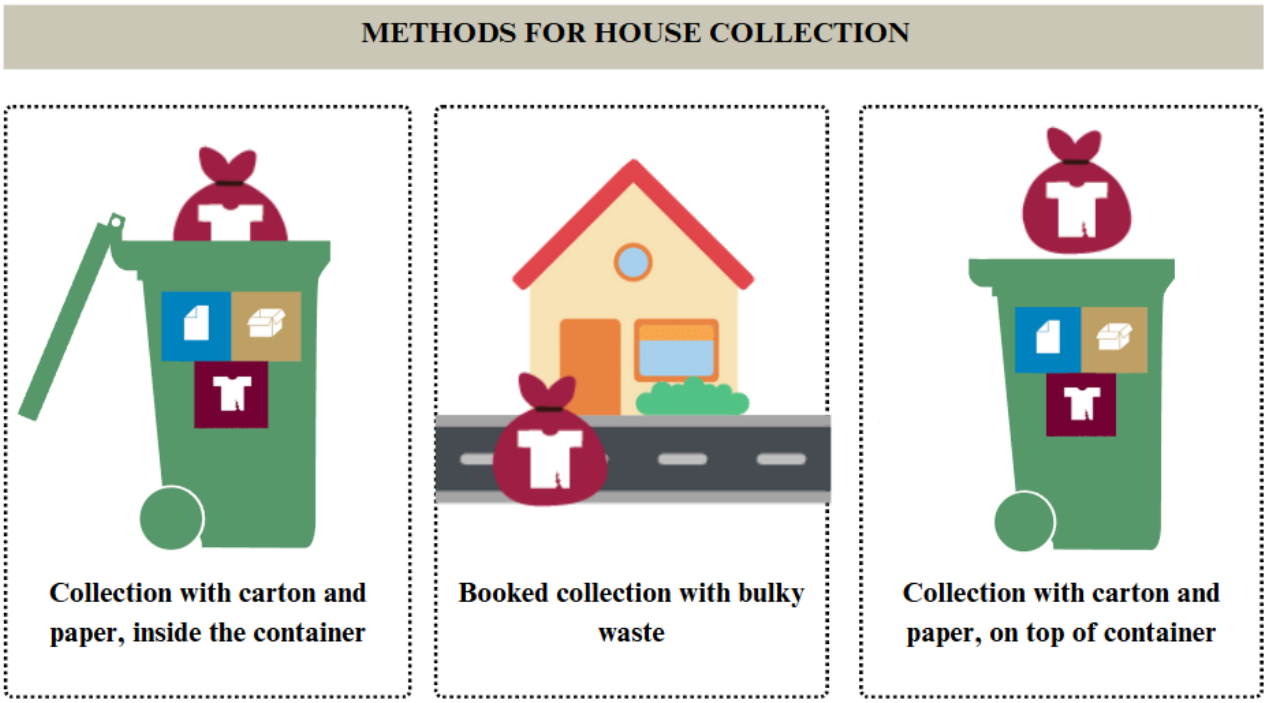


Figure 6: Visualisation of house collection methods

The first method I observed for house collection, was the collection of textile waste together with the waste fractions of cartons and paper. The citizen is instructed to hand in their textile waste in a closed bag and place it inside their 2-wheel (220-litre) container. The second method is another example of framing, which is the booked collection of textile waste. This method is based on the concept of "bulky waste", where the citizen can either book a collection or the collection is pre-planned based on a collection scheme. The citizens are instructed to place their textile waste in a sealed bag outside their homes or at a designated collection spot. From my conversations with municipalities that offer this method, including Test Municipality 1, I found that the collection workers are instructed to leave the bag if it is unsealed or wet and to remove objects that are not textile waste. The last method is like the first, but instead of placing the sealed bag inside the container, the citizen is instructed to place the bag on top of the container. These methods are examples of how framing based on existing practices has been used in implementing textile waste as a separate fraction. Using Shove's theory, it is based on the assumption that the citizen already possesses the necessary competence and practical knowledge to interact with the material, methods, and understands the meaning of the practice. However, as I will

elaborate in the following section on problem fractions, the links between competence, material and meaning in the practice of textile sorting, is still unformed (Shove, Pantzar, & Watson, 2012).

Methods for Collection at Apartment Housing

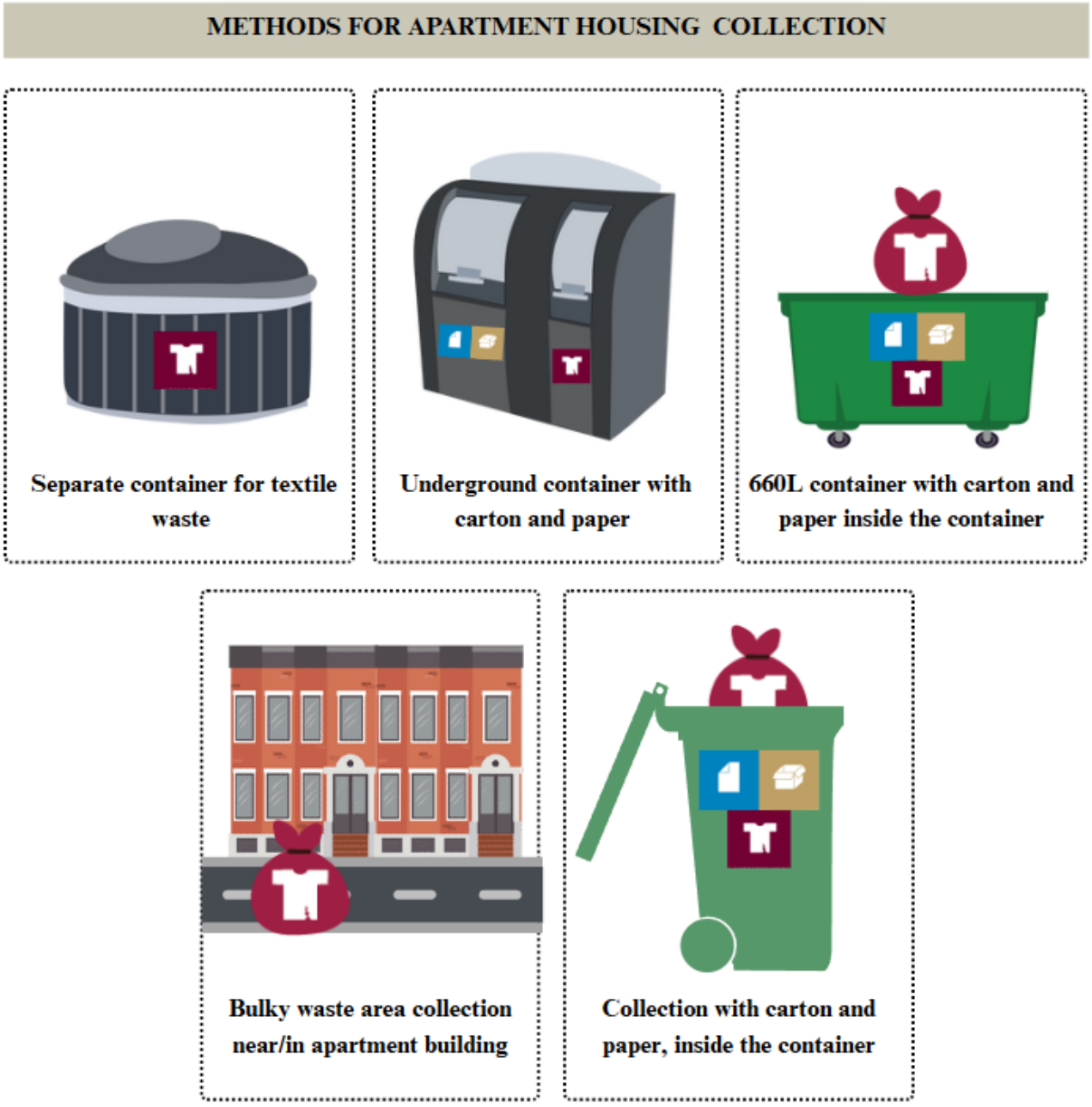


Figure 7: Visualisation for apartment collection methods

For apartment housing, I found a bigger dynamic in the methods used due to multiple variables. As with the house collection, framing of existing practices from the other 9 waste fractions has also been implemented here, adding an option of a separate container for textile waste. Collection from apartment housing falls under the standardised classification of "close to home" that states a container must be placed "within reasonable walking distance" from the address (Miljøstyrelsen, 2025). Framing is similarly used in three of the collection methods for apartment housing, with the 220 and 660-litre containers, as shown in Figure 7, where textiles are collected with cartons and paper and normally placed in the courtyard behind an apartment building, or in front. Depending on the building, the containers can be placed in "container hides" as e.g., sheds. The booked collection of textile waste, like with house collection, is either in front of the building or at a designated area. The last two methods, a separate container for textile waste and an underground container with cartons and paper are shared solutions more commonly used on streets as a method for multiple apartment complexes. As the section "Mapping Variables" will elaborate on, space is a main variable when deciding on a container solution, as it determines the frequency of emptying and what garbage truck can be allowed on the street. At the Dakofa conference, a spokesperson from Kredsløb, the WMO in Aarhus, shared how in larger cities like Aarhus, there are designated areas and space reserved for waste containers, and if more is needed, a special permit must be secured.

Methods for Collection in Public Spaces

The collection methods for public spaces are distinguished from apartment housing methods solely by placement. These methods must also be placed in public spaces to ensure easy access, but they are not part of the ‘close to home’ solution. Furthermore, an additional method has been implemented for this classification, which are small recycling stations referred to as "nearby stations". The nearby stations can be in the form of open shipping containers with containers for the different waste fractions placed inside, or can be a small indoor "store", placed close to the city centre.

Methods for Collection at Recycling Stations

The last classification covers collection methods at recycling stations, where the main distinction lies in the type of container used. Through my fieldwork, I established three different container types that can vary in design specifications, but the functionality is the same. The three container types are all part of the analysis I am performing on behalf of NewRetex in the SorTex project, meaning that the municipalities NewRetex works with are utilising these three: 10- or 20-feet shipping containers, 20 feet shipping containers with side gates and a 660L container as presented in Figure 8. The 10- or 20-foot container can either be used as it is, having citizens place the bag with textile waste directly inside the container or as NewRetex recommends, it can have metal cages placed inside. For the cage solution, the shipping container serves as a room for the citizen to walk into, to place their bags inside the cage. The functionality of the container with side gates is for the citizen to open the gates to then throw their bags directly inside the container. The 660-litre container can either be placed freely in the recycling station, commonly placed close to the NGO containers for second-hand or it can be placed under a roofed area.

Figure 8: Visualisation of recycling stations methods

Problem Mapping in Textile Waste Practice

Textile waste is the most fragile waste fraction of the now 10 waste fractions sorted, in Denmark and is also the most costly and complex fraction to handle. Additionally, I have found the industry to be very complex and closed. Therefore, the objective of this section is to present and analyse the problem fractions my research has found in dealing with textile waste management. As the end value of this thesis is" a guided method book" to handle textile waste in the most effective way, and to ensure the highest reuse and recyclability rates, I have chosen to compartmentalise the problem fractions in scales: industry, process and material scale challenges. The idea is for this to be a guided tool for other countries, like Sweden and Iceland, which do not have a fully implemented system, to learn from the challenges of Denmark. The objective of the outer layer, practices, which is visualised with a dotted line, is to show how both professional and consumer practices influence the challenges in the model. It is important to clarify that the visualisation of the scales is to show how they are all in interplay, and that one scale, e.g. industry, does not have a higher impact than e.g. the material scale. Furthermore, the process scale will also present a visual mapping of the value chain of textile waste management to localise where, in the process, challenges arise (Litster, Cardoso, & Hurst, 2024).

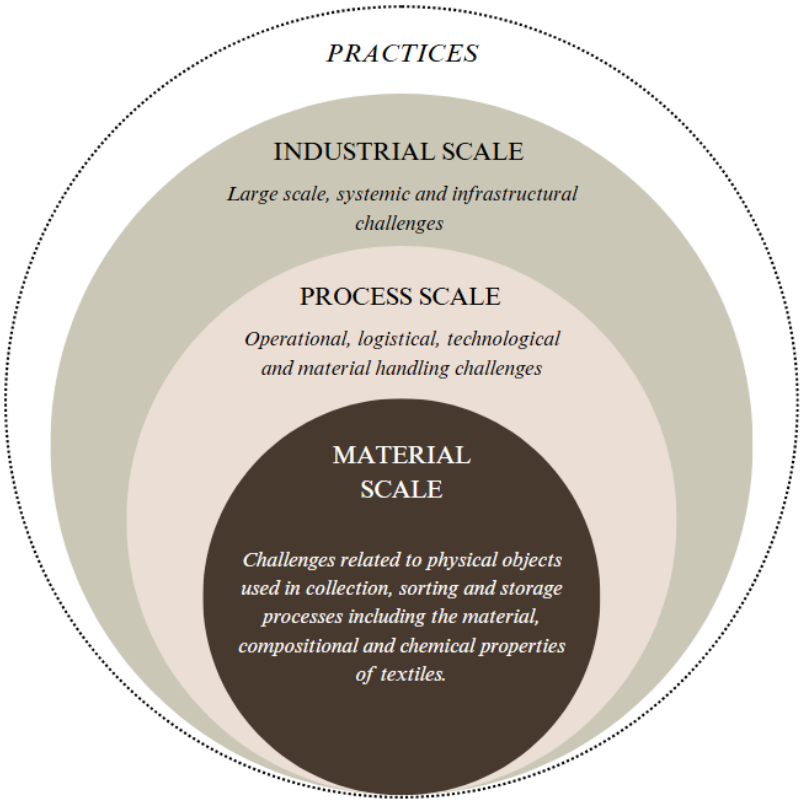


Figure 9: Visualisation of identified problem levels

Industrial Barriers

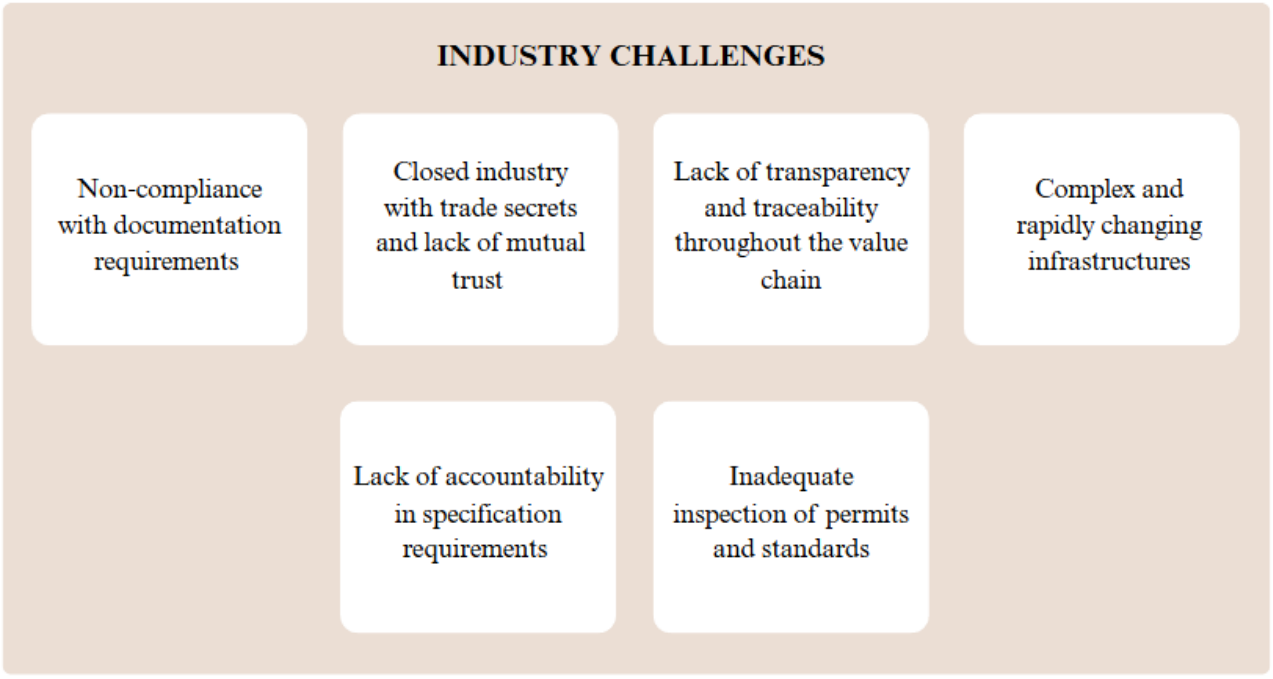


Figure 10: Industrial Challenges Overview

In design practice, interventions are tools for disrupting and investigating the status quo by intentionally introducing a designed object, system, process or experience into a specific context to explore, provoke, test or influence change (Dorst, 2011). My first research method was a design intervention to test the level of transparency and traceability in textile waste management systems by submitting a formal request for access to documentation under the Danish Public Administration Act. This law grants citizens the right to access publicly administered records (Borger, 2025). I applied for insight into the process of handling textile waste, including collection methods, the name of and the process at the contractor handling the textile waste after collection and the economic aspects of handling textile waste from 13 major WMOs. The aim was not to expose individual companies but instead highlight challenges that a potential "best practice" method book must consider when implementing in practice, to avoid radical and idealistic suggestions.

Through my intervention research I found that public administrations handling textile waste, face significant challenges in fulfilling the mandatory duty of documentation.The industry is therefore characterised by limited transparency and traceability, with several WMOs indicating difficulties in maintaining the journey of the textile waste after delivering the batch to their contractors. The majority of the WMOs expressed significant concern about the scope and formal nature of the request. Within 2 days, 6 out of 13 WMOs called me - 5 of them urging me to withdraw or narrow the request.

The remaining 5 only answered my Word document with short statements and no supporting documents. Only 3 organisations replied with attached documents. The reactions provided more insight into the industrial practices, than the documents and written responses. A preliminary interpretation of the responses could imply a reluctance to be transparent and comply with the legal requirement to provide documentation. While this interpretation cannot be entirely dismissed, further analysis indicates a reflection of the complexity of the system in which WMOs operate. WMO's function within a highly regulated environment, where responsibilities defined at national and EU levels are translated into practice across multiple organisational tiers. This often results in ambiguity regarding documentation requirements, especially in a context where regulatory frameworks are still evolving. The five organisations encouraging me to withdraw the request expressed clear frustration, which can be understood in relation to the formal nature of the process. As several explained, “it is a very official process” that requires significant resources and creates pressure to respond within seven days. Similarly, four organisations clarified that providing documentation was resource-intensive, as “they did not document the handling process for textile waste specifically”. This was further supported by the written responses from five additional organisations, which stated that they did not have documentation to attach, but were willing to answer the questions descriptively. Taken together, these responses indicate that the reactions are not only a response to the request itself, but a symptom of a broader lack of standardised documentation practices for textile waste management. This widespread lack of documentation points to challenges in meeting transparency and reporting expectations (EU, 2025), and suggests the absence of consistent and standardised approaches to documentation across organisations. This is one of the benefits of using design interventions in research, as it forces the recipient to “react” to their current situation. While the request followed an official process with a clearly stated objective, the variation in responses further reflects the complexity and resource demands associated with complying with such requirements in practice. One WMO declined the request, explaining that the scope of the project was too comprehensive and that “your application requesting right of access is denied as we find the requested amount of information disproportionate to its objective”. The organisation encouraged more “concrete” questions and noted that certain aspects of textile waste management could not be shared. In particular, the sorting process was described as “sensitive information” from a competitive standpoint for their contractors. Other WMOs similarly indicated limitations in what could be disclosed, particularly regarding financial data. While the responses varied, they point to broader constraints related to contractual obligations, competitive considerations, and the complexity of managing information across multiple actors in the value chain. Another objective of the request was to map contractors and their practices for comparison. However, only WMOs working with NewRetex as a contractor disclosed the identity of their partners, while the remaining organisations did not share this information. This further illustrates the fragmented nature of transparency within the system.

In a situational conversation with the tender coordinator at NewRetex, he shared that “to collect and receive textile waste in Denmark, you must be approved by the DEPA and receive a collection permit”, and the production manager shared that: “ you must have an environmental permit to get the collection permit, and to get the collection permit, you must take a collection course and exam”. The collection permit lasts for 5 years before it must be renewed. It is publicly available to look at the database of the Danish Energy Agency of which companies have the collection permit (Energistyrelsen, 2025). Through the website, I found that three of NewRetex’s biggest competitors do not have the required permit. When NewRetex attempted to report this, they were passed between the DEPA and the Energy Agency, neither aware who bore responsibility. This presents another structural challenge in translating regulatory responsibility into practice, here observed as a gap in the inspection and control of EU-delegated requirements, such as the collector's permit under the recognition of professional qualifications. From conversations with representatives from the DEPA, this is primarily as a resource issue rather than a practice issue. However, my findings suggest that this gap in ensuring accountability contributes to limited transparency and inconsistencies in traceability and documentation. Responsibility for documentation is delegated across multiple tiers —from EU regulation to national and municipal implementation, and further from WMOs to waste contractors. While WMOs include traceability and documentation requirements in their tender specifications, non-compliance at the contractor level—operating without a permit—creates gaps that affect the entire system. As a result, traceability is weakened across all tiers, placing WMOs in a position of indirect non-compliance. This is reflected in the responses to my request, where very few disclosed their contractor, only the few WMOs working with contractors holding valid permits shared these details. The use of non-compliant contractors introduces additional barriers to transparency, particularly regarding operational practices and accountability. In this way, textile waste management reflects dynamics similar to those of the fashion supply chain: the problem is not resolved, but delegated and inherited across actors. Another example of how these gaps in compliance and transparency manifest in practice is reflected in insights from tender coordinators within compliant WMOs. Several referred to industry “trade rumours” of contractors receiving textile waste and reclassifying the waste code to enable incineration and maintain lower costs.At the same time, a review of tender specifications shows that none explicitly require a collector’s permit, focusing instead on environmental certification of machinery and certified weighing systems. This indicates that key compliance requirements are not consistently embedded in procurement criteria, contributing to gaps in traceability and enforcement.

Through participatory observations at two big conferences, respectively held by the trade organisation and the competence centre for the circular transition, Dakofa, and by the steering group behind SorTex, which was conducted over two days, I gained insights that further proved that the industry is highly complex and rapidly changing.

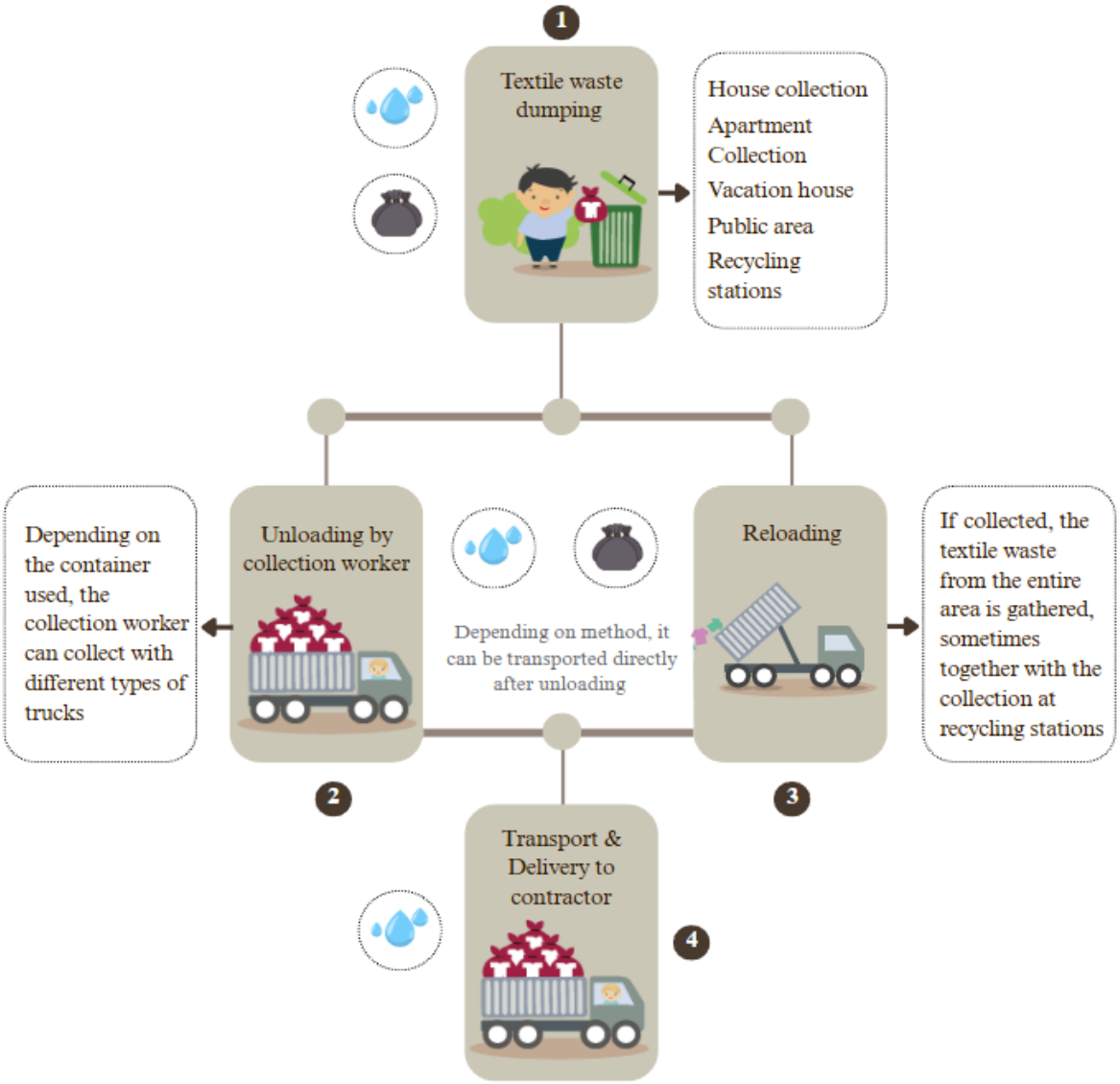
Due to the complexity, there is a lack of streamlined solutions - municipalities are hesitant to invest in new solutions while policy frameworks remain uncertain, with the wait for the action plan from the EPR system. In addition, until the SorTex conference in late April, shoes were excluded from the standardised classification for textile waste. At the conference, however, an employee of the DEPA shared that in the next revision of the waste plan, shoes would now be included. I will elaborate on this more in the prototyping section; however, this showed me how imperative it is for the industry to be adaptation-ready, but it is challenging to agree on solutions if they are seen as temporary and potentially expensive. In relation to costs and high complexity, the WMO that had declined my request later agreed to an interview and shared that: "recycling is not the solution to textile waste. The only real solution is to stop mass production and not manage the waste it creates". In my response, I agreed, of course, on the need to stop mass production, but asked whether her stance on recycling was because she does not believe in a viable solution within the current system—as addressing mass production is an equally complex issue, requiring a debate on supply versus demand and the distribution of responsibility between top-down and bottom-up approaches. She added that: “There is money in reuse, not in recycling. There is a whole market for selling used textiles to Africa and Latin America. NGOs and municipalities earn on reuse but have to pay for recycling, and there is no market for it”. Interestingly, while the WMO points to how manufacturers prioritise profit over sustainability, she admits *“there is money in reuse, not in recycling”* - despite current reuse-systems contributing to landfills in the Global South. This reflects how accountability is deflected across the system, both upwards and downwards depending on position, while the same profit-driven logic is repeated locally. From the specification requirements, I found another case of deflecting accountability, specifically with “the quality of the textile waste”, as there is no explicit mention of the WMO's role in ensuring the quality of the textile waste. However, it states explicitly that “ the responsibility for the quality transfers to the contractor upon delivery”.

My research reveals how the act of asking questions itself becomes threatening when a system lacks clarity, structure and a consensus for transparency. The pushback, confusion, and dismissal I encountered are not side effects - they are symptoms of a field in transition, without shared standards, traceability, or even a common vision. In this sense, the intervention functioned as a diagnostic tool, revealing fractures in the infrastructure of textile waste governance. Without applying for the rights of access and having been met with these responses, I wouldn't have found how various WMOs are non-compliant with documentation and reporting requirements and how closed an industry it is – making collaboration and a potential streamlining a complex task.

Process Barriers

I have designed the model in Figure 11, split into two sections: the Collection Process and the Sorting and Recycling Process, to clarify the interplay between the different steps - from collection and transportation of textile waste to the contractor's sorting and recycling operations (e.g., NewRetex). In the mapping of The Collection Process, I have included a water and a trash symbol, which symbolise when in the process there is a chance of the primary problems fractions of water and other waste contamination, based on my fieldwork.

Figure 11: Mapping of the Collection Process



Step 1: Textile waste dumping

For both the pick-up schemes and delivery at recycling stations, I found that the disposal step of the collection phase is where there is the highest risk for contamination of water and other waste fractions, which is due to either container type, practice regarding protection against rain, the practice of collection workers, and with a big impact on the quality of the collected textile waste also being from the citizens' practice level. In other words, the quality of the collected material is deeply shaped by how the social practice of textile waste disposal is shaped for the individual citizen and municipality. From my participatory observation, and later loose conversations, with the pre-sorting at NewRetex, I found that citizens hand in the textiles loose, not in a sealed bag, making it vulnerable to water exposure and that they hand in other waste fractions. At NewRetex, they receive anything from food waste, bicycle parts, broken glass and knives, dirty diapers and other dangerous and harmful items. Some of the WMOs reported additional issues in the practice level, with Test Municipality 1 sharing that the textile waste can also have been handed in already wet, as they had experienced citizens handing it in directly after washing it, thinking that it just had to be clean, not dry. The WMO responsible for Test Municipalities 2 and 3 shared that: “at our recycling station in (municipality 2) we experienced issues with citizens leaving the side gates of the container open after disposal, making it easier for rain to enter, so we had to permanently seal the side gates and have them dispose through the end-doors of the container so our collection workers could ensure the gates were closed”. From Shove's notion of social practices, this reflects a lack of competence and meaning regarding the material for proper disposal. Based on the received quality of textile waste, it seems that citizens lack knowledge of the vulnerability of textiles and the meaning behind why they must be bagged and sealed to prevent moisture and contamination to be eligible for reuse or recycling. It indicates a disconnect in meaning, with the citizens not perceiving the practice of proper sorting as significant or worth the effort. Furthermore, they might lack knowledge and a sense of meaning of the classifications, acting based on their instinctive classification instead of the standardised ones from the government
(Bowker & Star, 2000). The material available and the practice of the individual municipality likewise influence the practice of citizens, as a lack of bags, unclear signage or a poorly designed collection container can lead to the incorrect disposal of the textile waste (Shove, Pantzar, & Watson, 2012). However, I argue that the social significance, the meaning attached to sorting textile waste correctly, has the highest influence on the effort to gain the needed competence.

Step 2: Unloading

In my ethnographic research of the unloading phase, I took a specialised focus on how the different WMOs and municipalities empty the containers, what material and practical aspects are present in the step and how it varies between the different collection methods. My first semi-structured interview was during a visit with Test Municipality 1, where I asked how they empty the containers and what determines when and how often. The head of waste for Test Municipality 1 shared that: “a WMO or municipality can either have their own transport department, like we do, or they can lease the transportation from an external company, and then it depends on the company which type of truck is used”. During the interview I discovered an essential term linked to the process, "Frequency of Emptying", which refers to how often the containers are emptied, and that it is based on the average “Loading Degree”, which refers to how full the container is before emptying. At the Dakofa conference, I found that the longest Frequency of Emptying is with the collection by vacation homes, as it is only emptied every 8 weeks due to the low Loading Degree at both the recycling stations and the containers at the homes, which is often the container mixed with carton and paper. In addition, the tender coordinator at NewRetex told me that they receive the most wet textiles per batch from a WMO that delivers with an interval of every 2-4 months, leading me to analyse the correlation between Frequency of Emptying and the amount of wet, which I will unfold in the “Mapping of Variables” section.

In addition, I found that different types of collection trucks pose different types of contamination risks. The classical compactor-garbage truck compresses its content to allow for more space, which risks physical damage to the bags and clothes, as its knife can cut the bags open. This can allow moisture to enter and can cut up the clothes that could otherwise have been sorted for second-hand. As part of the project, we (NewRetex) got the opportunity to test the quality of textile waste being collected by a compactor-garbage truck, as NewRetex gained a new customer that utilises that method. The images in Figure 12 show how pillows and plastic bags with textiles have been cut open from the compactor.

Figure 12: Pictures from Test

From a semi-structured interview with Test Municipality 1 and loose conversations with the other municipalities, I found that another common problem in the unloading step is with the collection trucks that have top gates. Many of the municipalities shared that they had experienced the collection workers leaving the gates open while unloading the containers, which means that if it's raining, a pool of water will form in the truck, and all the clothes not in sealed bags will get wet. This introduces a third problem area in the unloading step, which is if the unloading takes place on a day when it rains.

This indicates, as with the citizens, that the competence level of the collection workers also has a high impact on the process, and that the lack of awareness or training in the sensitivity of textile waste regarding water exposure and compression damage leads to the practice of leaving the truck gates open or using the compactor, which can ruin the reuse and recyclability of the textiles. The material level, the design of the collection trucks, designed for traditional waste methods with built-in compactors and open loading mechanisms, is a direct enabler for damaging practices. However, I would argue that, as with the citizens, the meaning level has the greatest impact (Shove, Pantzar, & Watson, 2012). For the collecting workers, the meaning of unloading textile waste might be "framed" from handling general waste - a task to be completed efficiently, with little emphasis on material preservation. If textile waste is seen as having the same social and symbolic significance as other waste fractions that are less vulnerable, collection workers are unlikely to modify their handling practices to protect quality. In the unloading step, I find that the material and meaning

levels are particularly powerful barriers to quality preservation, while competence can be improved through training. However, if the link between competence and meaning isn't formed, to handle the material correctly (the trucks and textile waste), the barriers remain (Shove, Pantzar, & Watson, 2012).

Steps 3 and 4: Reloading and Transport, and Delivery at the Contractor

Reloading is the practice of transferring textile waste from smaller local collection vehicles to larger transport trucks or containers for long-distance delivery. This step typically occurs at reloading stations or at a transfer hub. Test Municipality 1 shared they are experiencing challenges in the reloading because the textiles are drawing in moisture at their reloading station as the area is not acclimatised or completely sealed off from weather, like temperature or rain.

Figure 13: Picture from Reloading Station

In addition, they shared that citizens are looking through the containers when they have been placed in the reloading central: “some parents come into the station and lower their kids into the containers to then take out bags of textile waste. Then they put an open bag or loose textiles back into the container, and the bag might originally have been closed”.

During transportation to the contractor site, e.g. NewRetex, there is a chance of water coming into the truck's container, depending on the type of truck and whether it rains, as some containers have holes and gates that aren't waterproof. Depending on the type of delivery at the sorting contractor, the delivery step can also pose a risk of water exposure. NewRetex has built an extra hall, which is completely covered, that the truck reverses into, so the textile waste is offloaded onto the conveyor belt in a dry and cold environment so that the textiles don't condense (see Figure 14).

Figure 14: Reception Hall NewRetex

However, through many conversations with NewRetex and driving by one of NewRetex's competitors every day for 4 months, I found just how important the delivery step is. Looking at Figure 15, this contractor receives and stores the textile waste outside, where it stays for months before it is manually handled by a sack trolley or manual labour. In the pictures, there are loose textiles amongst the bags, and even with bags, there is still a chance of holes and improperly sealed bags. This type of practice for delivery poses significant risks of water exposure, with the textile waste being exposed to rain over extensive periods. The practice signals a very low level of meaning and significance attached to the preservation of quality. As mentioned with trade secrets in the industry, the tender coordinator shared that: “We do not know this officially, but it is a known practice among certain contractors to re-classify textile waste with another waste code that allows for incineration. This helps them keep their prices down and win tenders as incineration costs 1DKK pr. Kg, and sorting according to the WFD costs 5DKK pr.kg, which is our gate-free”. He also mentions that this is one of the competitive challenges NewRetex faces.

Figure 15: Reception at Competitor

By permitting textile waste exposure to water, allowing them to send it directly to incineration, this makes one question the intentionality of them doing it to keep their prices down, purposefully.

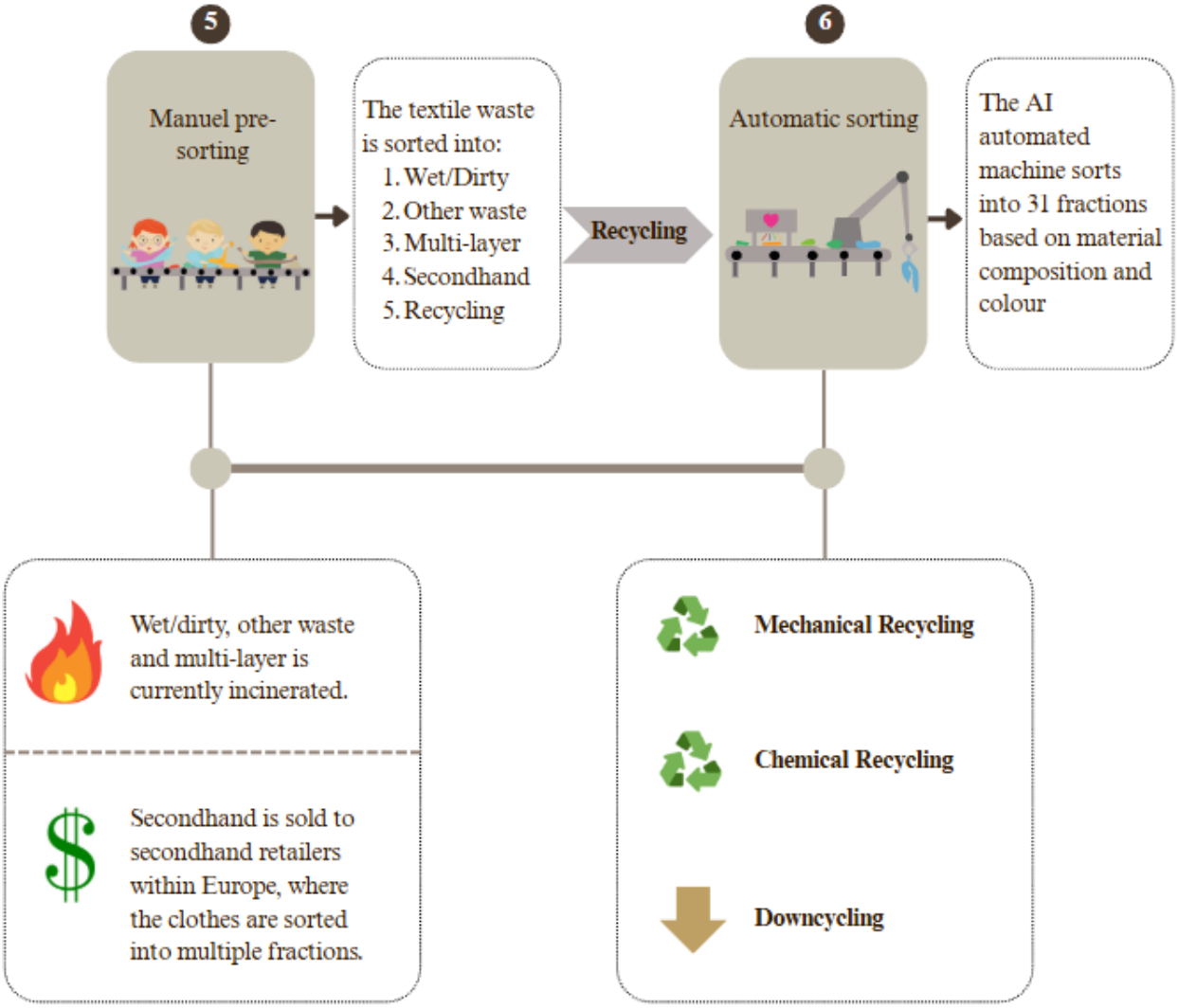


Figure 16: Mapping of Sorting Process at NewRetex

Steps 5 and 6: Manual Pre-sorting and Automatic Sorting

As I am collaborating with NewRetex, and have not been able to access the practices of other sorting and recycling contractors, I will simply be referring to the process of sorting and recycling for NewRetex. After the delivery, the textiles go through what is referred to as manual pre-sorting. To ensure full traceability through the whole process, NewRetex sorts a batch at a time. As mentioned, I have participated in the pre-sorting of a full batch, which took 8 hours to sort. Using Bowker and Star, NewRetex utilised a localised classification system, which the tender coordinator shared is a common classification system used in the profession of textile sorting. The textiles are sorted into the following classifications: wet or dirty, other waste, multi-layered, second-hand and lastly, recycling. I will be going further into the classification of other waste and second-hand at the

end of the next section on material barriers. After the manual sorting, the textiles that are not classified as second-hand go into NewRetex' automatic sorting machine, which categorises the textiles based on material composition and colour. The production development engineer shared that: "whether the textiles go into mechanical or chemical recycling or downcycling, is based on the material composition and colour, and whether there is a certain market demand for recycled cotton or other fibre sorts".

Material Barriers

In this section, I will primarily be analysing the functionality of the different types of containers utilised in the collection of textile waste mapped in the previous section. In addition, I will be including the barriers of the materiality of textiles, as well as the consequences of the classification of textile waste. Through my participatory observations, interviews and situational conversations with NewRetex's employees, the employees at the municipalities and WMOs, and other actors in the waste industry, it is evident that the most significant barriers (problem fractions) against the reuse and recyclability rates of textile waste are ***water*** and ***other waste fractions*** contaminating the textile waste throughout the collection process, as mentioned in the process mapping. The quantitative data from the NewRetex MES system supports these qualitative findings with an average percentage of ***13% wet*** and ***16% other waste***. It has been repeatedly confirmed to me from employees in the waste industry that textile waste is the most vulnerable, complex and costly waste fraction. In a meeting regarding the formation of a collaboration between NewRetex and a WMO, a WMO employee from Iceland shared that textile waste: "is complicated, expensive and cannot endure any mistakes in the collection - it would be ten times easier and cheaper to burn it all, but of course we cannot do that". This is due to the mentioned EU legislation, prohibiting the incineration of unsold textiles and textile waste from 2025; however, the cost of sorting textiles for reuse or recycling is significantly more expensive than incineration. According to the founder of NewRetex, textiles are especially vulnerable due to their low durability and resistance, making them susceptible to stains and mould. She shared that: "If a garment or piece of fabric is wet, it is impossible to know whether a mould spore has already formed in the material. If a mould spore has formed, the fabric is contaminated and can no longer be recycled, as that mould spore will be transferred into the new recycled fibre".

Materiality of Collection Containers

As mentioned, there are six test municipalities divided into four waste management organisations (WMOs), referred to as Test Municipality 1, WMO 1, WMO 2 and Test Municipality 6. WMO 1 has four municipalities and recycling stations, and WMO 2 has six municipalities and recycling stations. Test Municipality 1 and Test Municipality 6 are single municipalities having internal control of their waste handling, outside of a management organisation.

As NewRetex primarily receives textile waste collected from recycling stations, we called a municipality that sends their textile waste from recycling stations to NewRetex, asking if we could run a test on a batch from their house picked method, using a 220L container where the citizens are advised to place the red bag on top of the lid. Before running the test, there was a shared assumption internally at NewRetex and amongst the SorTex partners that house-picked textile waste, on average, has a lower amount of other waste. The assumption is based on the size of the containers, 200L in this case, not allowing for bigger waste fractions such as mattresses to be thrown in with the textile waste.

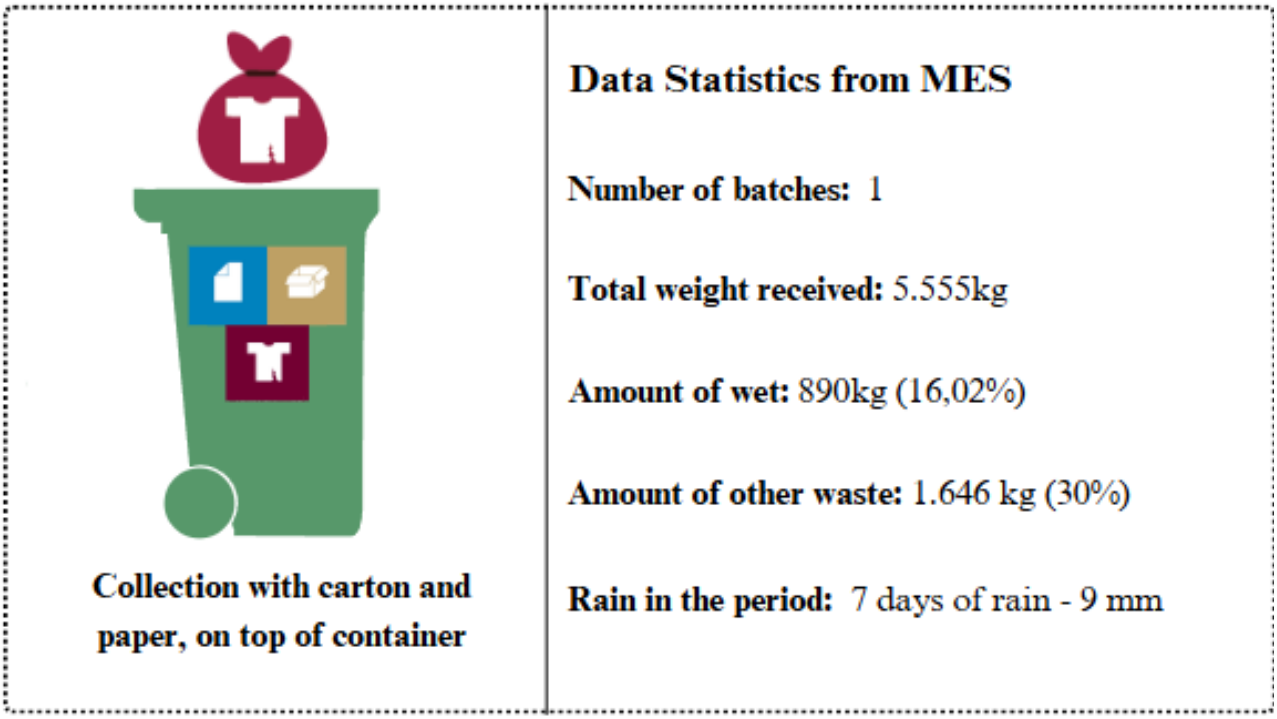


Figure 17: Statistics from the MES System

However, the test batch shows that 30% (1.646 kg) of 5.555 kg is other waste, therefore debunking the assumption. The initial objective of testing the house collection methods, was to receive the textile waste before it was separated from the carton and paper. We received the batch of textile waste from Figure 18 without the carton and paper, as the bags were directly removed and collected for us. In addition, we had contacted another external municipality, who utilises the underground container method, collected with carton and paper to run a test, however due to the late response time, it was no longer possible as they were making a new tender round, and it could be considered favourtism to send a test batch to us. Therefore, unfortunately, I have not been able to include all the different house collection methods in the analysis.

Collection with carton and paper, inside the container

Data Statistics from MES

Number of batches: 1

Total weight received: 2.045 kg

Textiles received: 133 kg

Amount of wet: 0kg

Amount of other waste: 39kg

Amount of carton and paper: 1912 kg

Figure 18: Statistics from the MES System

For the collection method using 220L containers with the bag placed inside, we contacted another external municipality, which agreed to send a test batch. We received a total of 2.045 kilos hereof 1912kg carton and paper, and I was observing while it was being delivered onto the conveyor belt, with a special focus on the amount of textiles amongst the carton and paper, and how easy it was to manage. The first observation I made was that it looked to be purely carton and paper and that the functionality of the conveyor belt was not suited for carton and paper, it could receive it but not compress it, meaning that it was taking up space making it difficult to fit the remaining batches of that day. Out of the 2.045 kg there was only 133kg textiles, and although there was no wet textiles, there was a lot of dirty textiles meaning that no textiles was eligible for reuse.

In my semi-strucutered interview with WMO 1, they shared that their contractor for the house collected textile waste, which is also together with carton and paper inside the container, is experiencing a big issue with the amount of wet.

Figure 19: Pictures from Delivery

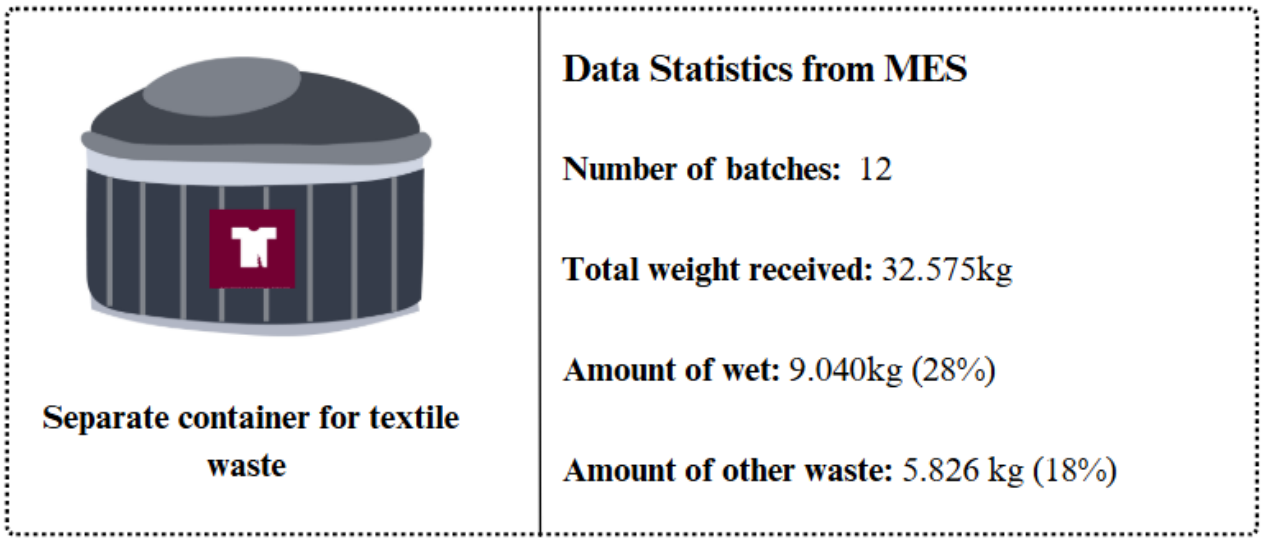


Figure 20: Statistics from the MES

The municipality utilising this solution is not part of the SorTex projects test municipalities; however, to cover all the different collection methods, we chose to include all data in the MES. There is one municipality in the NewRetex database utilising this method. In Danish, they are called “molokker” and are overground containers with a top gate. The container is part of the framing from previous waste fractions, primarily used for glass and food waste. There is a need for a re-framing due to the containers not being reserved solely for textile waste but are in a loop between the

different fractions. This means that a container that has been emptied, previously used for glass, can be used for textile waste – the issue that the employees in the pre-sorting has experienced is that broken glass and food waste come in with the textile waste, contaminating it. In a batch from July 2024, the production had commented the MES that everything was wet and full of broken glass, resulting in the data showing 1.936kg out of 2.130kg being wet (91%) and only 129kg (6%) coming into the automated sorting, with no clothes suitable for reuse. In another batch from August 2024, the production made a comment on the MES that: "the rest discarded due to food waste and wet", resulting in 1.800kg (42%) out of 4.320kg being classified as other waste – mainly due to food waste or food waste covered textiles – and 1.092kg (25.3%) being wet.

660L containers

Data Statistics from MES

Number of batches: 11

Total weight received: 60.447kg

Amount of wet: 4.865kg (8%)

Amount of other waste: 12.363 kg (21%)

Figure 21: Statistics from MES

For Test Municipality 1, they have 660L containers at their recycling stations, placed under a half-roof to shield them from the weather. Looking at the average statistics, 8% is only 1% from being the desired maximum of wet according to the desired value from NewRetex and SorTex. However, it is the individual batches that are interesting, as will be elaborated on in the mapping of variables. They do, however have a large percentage of the other waste fraction.

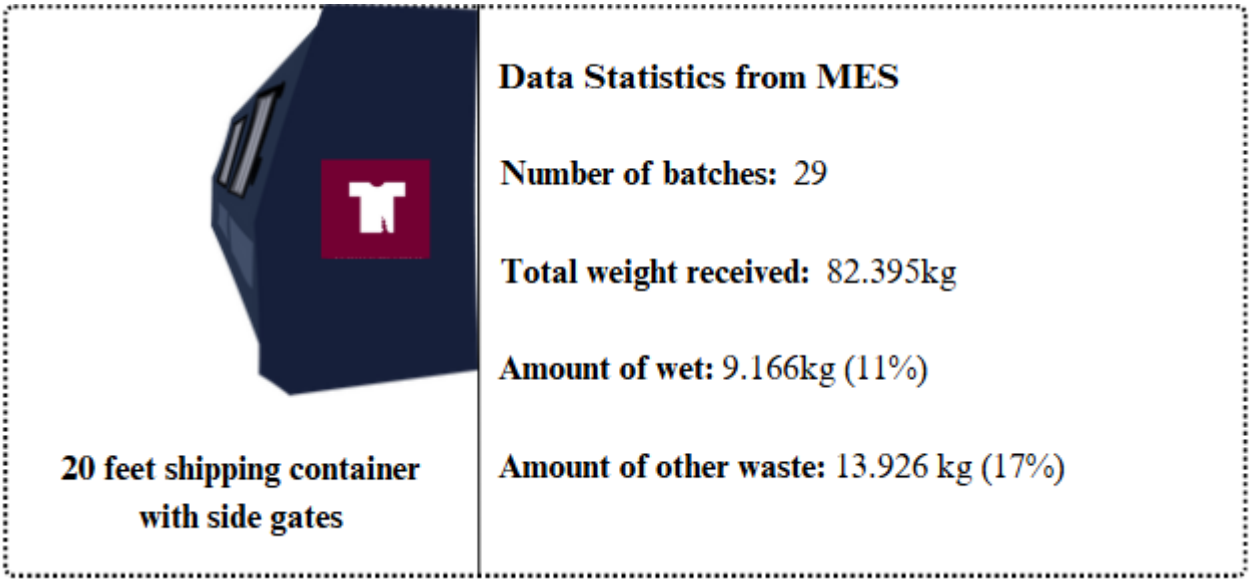


Figure 22: WMO 1 data

In a semi-structured interview with a Zealand-based WMO, and through conversations at conferences, I learned that side gates on containers are a recurring issue: they are often left open, letting rain in, and even when closed, water seeps through the unsealed design. Figure 22 shows the average percentage of wet textiles and other waste from the total weight recevied for the collection method used by WMO 1; a container with side gates where they have permanently closed the side gates, using the container as a regular shipping container. WMO 2 utilises the same container for their municipalities, but uses the functionality of the side gates, a practice that shows a significant impact on the amount of wet textiles. In July 2024, rainfall in the three test municipalities averaged 130–140 mm across 16–18 rainy days. Yet the municipalities under WMO 1 reported only 6–7% wet textiles, while one municipality under WMO 2 reported 15%.

20 feet shipping container with side gates

Data Statistics from MES

Number of batches: 28

Total weight received: 97.320kg

Amount of wet: 32.713kg (34%)

Amount of other waste: 10.776 kg (11%)

Figure 23: WMO 2 data

The difference between the data for WMO 1 and 2 proves how the material design of the containers used in the collection method will not solve the issues regarding wet textiles and other waste - the solution is found in the interplay between design and practice. Across seven municipalities, WMO 2 records an average of 34% wet textiles, while WMO 1 averages only 11%. This represents a 209% higher share of wet textiles in WMO 2, despite the use of the same container type.

10/20 feet shipping container with cages inside

Data Statistics from MES

Number of batches: 82

Total weight received: 233.284kg

Amount of wet: 24.146kg (10%)

Amount of other waste: 40.678 kg (17.4%)

Figure 24: Data from Shipping Container with Cages

As mentioned, the test municipalities presented have shown not to be inclusive of all the collection methods used in Denmark, as they together only cover 2 collection methods, 660L containers and containers with side gates. Therefore, as mentioned, I have included more municipalities to cover as many collection methods as possible. For the 20-feet shipping container, I have included one of NewRetex prior WMOs, that has delivered 324.134kg, divided between two container methods: 20-feet shipping containers with roller cages inside, and without roller cages inside. The tender coordinator explained that: "The roller cages were an attempt to lower the amount of bigger other waste objects such as mattresses, as the size of the roller cages doesn't allow the citizens to place them in the cages". However, looking only at the quantitative data from the MES system, the amount of other waste is higher with the roller cage solutions as it has an average percentage of 17.4% versus 15% in the method without the roller cages (see Figure 24 and 25).

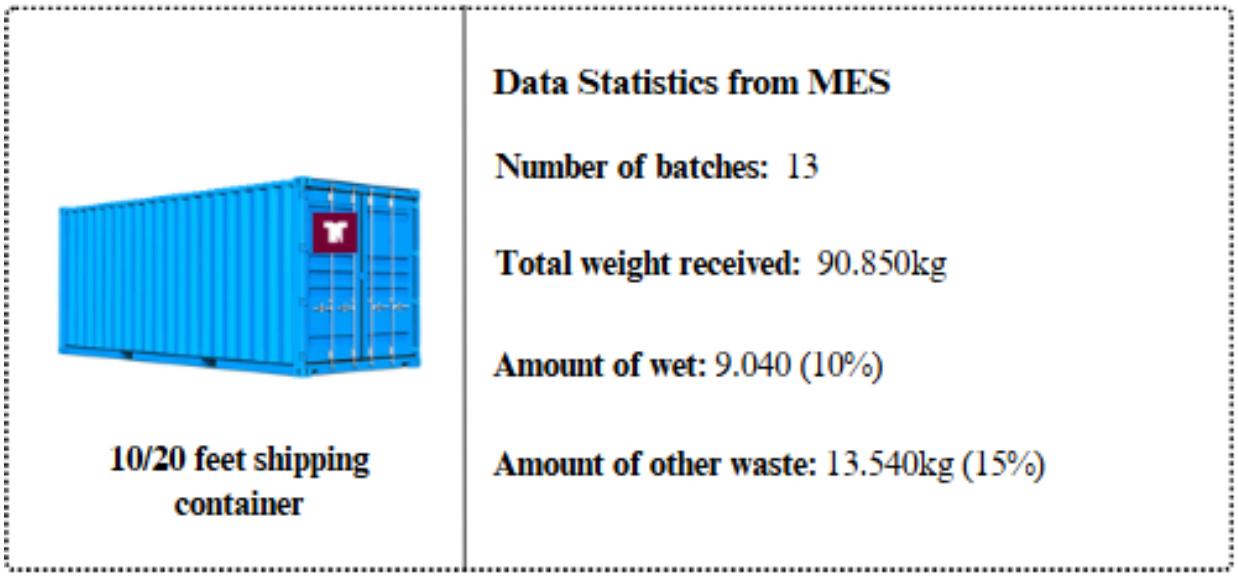


Figure 25: Data from Shipping Containers without Shipping Containers

Based on the presented data from the MES system for each collection method, I have ranked the methods in terms of best- and worst-case scenarios, looking at the indicators for wet and other waste fractions. I will be analysing the significance of the presented data for each of the methods in the following section, mapping the variables that impact the different indicators to establish the validity of the data.

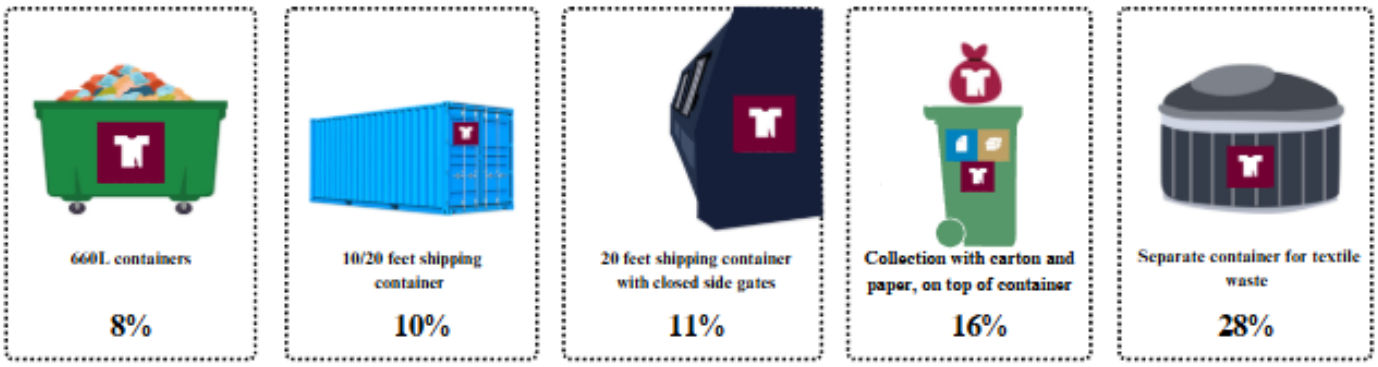


Figure 26: Overview of percentages of wet

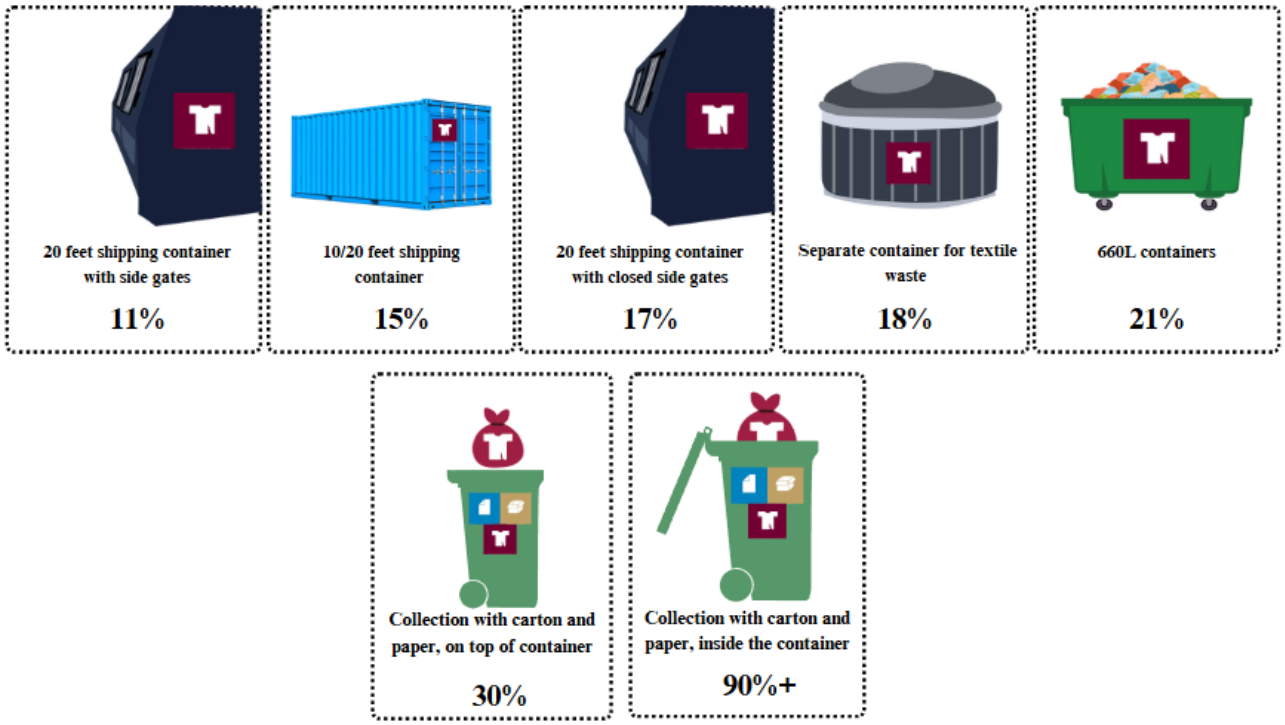


Figure 27: "Other waste" percentages

I argue that the "other waste" fraction is the most problematic fraction to intervene in, as it is heavily based on tensions between standardised and localised classifications, which I will unfold in the consequences of material classification. In addition, the presence of other waste ultimately comes down to a disconnect in the practice level of the citizens, particularly the meaning level – if they see no meaning with the practice and have no interest in the reuse or recycling of textile waste, they will not engage in proper t practices, leading to the disposal of their other waste fractions in the most available container (Shove, Pantzar, & Watson, 2012).

Consequences of Material Classification

Figure 29: Textile Waste Pictogram

Figure 30: Second-hand Pictogram

Figure 28: Residual Waste Pictogram

Textile waste can be classified through a globalised, standardised, localised and informal system, which is creating tensions with the material handling. The EU has mandated a globalised system for textile waste, the Waste Framework, while individual countries implement standardised (national) and then localised interpretations. For instance, for textile waste, Finland excludes items like socks, underwear, and blankets, whereas Denmark includes them in the classification (Poistotekstiili, 2025). DEPA's standardised classification for textile waste is "textiles others cannot get value from e.g. destroyed textiles, full of holes, stained textiles, single socks, worn out underwear, towels, curtains, blankets with dried stains from food or wine - but not from paint or oils - worn out rags, cut-offs and single gloves e.g. in cotton or wool" (Miljøstyrelsen, 2025). There are some tensions in this classification, as the meaning of "worn-out" invites for instinctive and subjective classification, and from fieldwork, situational conversations, and interviews with NewRetex and SorTex partners, I found that items such as socks and underwear are materially unfit for mechanical and chemical recycling due to their high elastane content making them technologically incompatible with fibre-opening, dissolving processes. As Bowker and Star argue, once a classification is enacted, it becomes real, guiding actions, perceptions and is difficult to undo, and that, "each standard and category valorises some point of view and silences another. This is politics by other means" (Bowker & Star, 2000, s. 5). The formal classification "silences" the material reality, overlooking the material limitations but due to the Waste Framework they are classified as textile waste with recycling in mind if they aren't reuseable, whereas NewRetex and other contractors are operators of a local and material based classification system, creating conflict between formal standards and situated practice (Bowker & Star, 2000). Similarly, in this relation "residual waste" is formally classified as anything outside the textile waste classification. Yet in practice, NewRetex internally adds to this classification, calling it "other waste", which includes textiles with sequins, glitter-thread or rhinestones, items smaller than 25x25 cm and socks and underwear.

Sequins and glitter threads are soft plastics and therefore not textiles and separation is too resource intensive. Thus, the classification of textile waste evolves on a local, practical basis—driven by material constraints, not just global policy.

Second-hand sorting is governed by informal and often inconsistent classifications. Denmark defines second-hand clothes as "not damaged and of value to others," yet value is a highly subjective term. Sorting practices are often carried out by volunteers whose value judgments influence whether an item is reused or discarded. From visiting Horsens municipality's Jobcentre, where they pre-sort their textile waste before sending it to NewRetex, the citizens at Horsens' Jobcentre, working at the pre-sorting, all have different nationalities. From a situational conversation, a Ukrainian lady shared with me how she felt "it is absurd what Danes classify as worn out, it seems very privileged, I know it sounds bad but to me it is privileged as most of the clothes looks perfectly wearable and intact". According to the production manager at NewRetex there are four primary classifications recognised in the industry, Original (Premium grade), Grade 1, 2, 3 and Grade 4 referring to irreparable items for recycling (Preworn, 2025). Those are likewise the globalised classifications for second-hand sorting. However, NewRetex has reframed the globalised classifications, using a localised practice that classifies everything after Grade 1 as textiles for recycling. This is because the globalised practice of second-hand builds on the symbolic meaning that someone in a third world country can use our, the global north's, worn-out clothes, as it is only the premium and first-grade conditions that are kept and, according to the Sales Manager at NewRetex, sellable in Europe. As NewRetex has established a contractual agreement with its second-hand market partners, any items that cannot be sold within the EU must be returned, ensuring that they do not contribute to landfill outside the region. This provides NewRetex with a clear benchmark for the quality standards required for resale within the EU market, and is the foundation of their localisted classification. The consequences of the tension between the classifications of textile waste and reuse are the significant amount of textiles ending up in landfills in the global south, a strong claim, but a sad truth, with at least 15 million used garments entering Accra in Ghana weekly from Europe, the UK, North America and Australia. In countries like Ghana, they refer to the second-hand clothes they receive as "dead white man's clothes" as 40% of all imported second-hand clothes become waste – as they are unsellable or unwearable - ending up in landfills and polluting local environments (see Figure 31) (Zeuth, 2025).

Figure 31: Pictures from Fashion Dumpsite

The globalised classification of “second-hand” masks the reality that many of these textiles "deemed reuseable" should have been sorted as textile waste before export and sent to recycling. In sum, classification systems are not just technical—they are political, material, and social. They reflect tensions between global standardisation and local reality, between policy and practice, and between intention and outcome. Understanding and addressing these tensions is essential for designing classification systems that are effective, just, and sustainable. We should not blame the individual actors, but we have to understand the individual practices, and if these competencies aren’t shared in an infrastructure, they will be locally embedded and cannot create value in practice.

Mapping Variables for the Collection of Textile Waste

The objective of the following section is to map the variables identified through my fieldwork, to analyse their correlations with key indicators, specifically the amount of wet and dirty textiles, as this contamination has the highest observed influence on reuse and recycling rates. The mapping is designed to illustrate how the identified variables primarily affect the occurrence of wet textiles, and subsequently other waste fractions, across different stages of the waste management process. This builds on the practice and problem mapping presented in the previous section. By mapping variables, the analysis enables the identification of relationships, dependencies, and inconsistencies within a system. What is effective ine one municipal context, may not be directly transferable to another, unless variable differences are made explicit to inform the design reasoning.

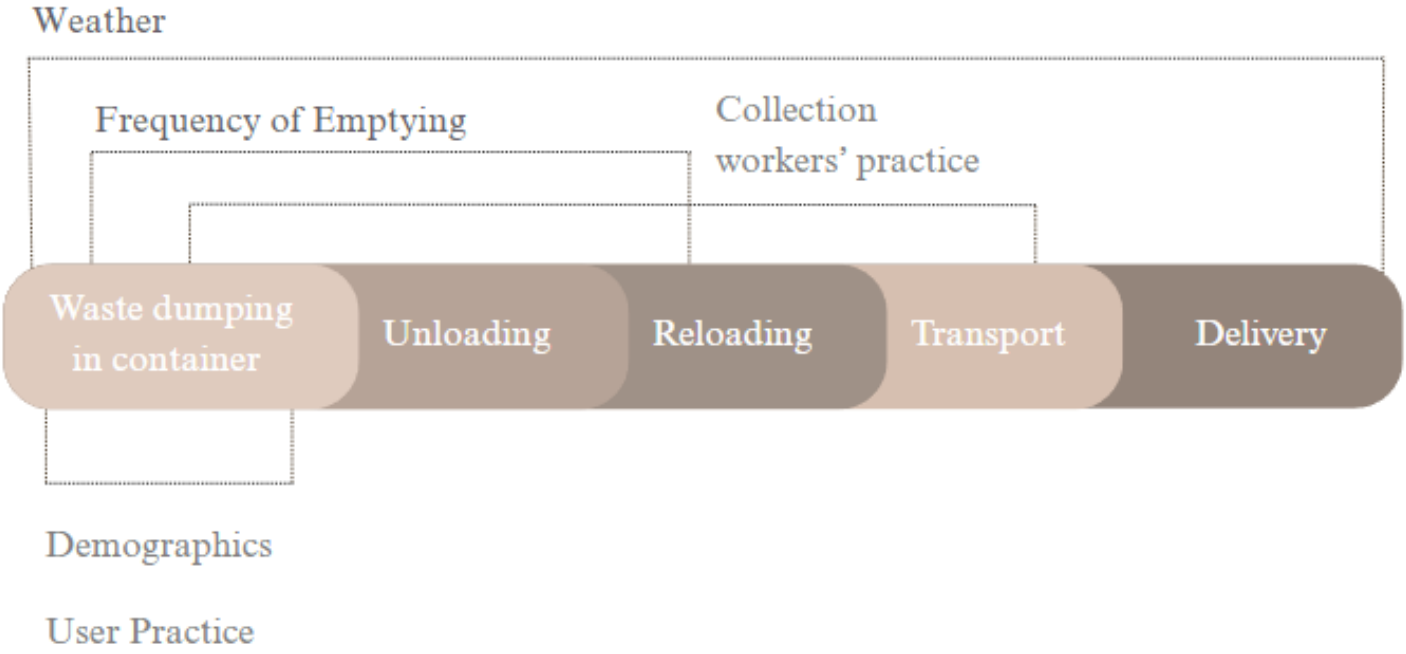


Figure 32: Variables in the Collection Process from Field Observations

During my semi-structured interviews with Test Municipality 1 and WMO 1, conducted in relation to procausations following the introduction of textile waste as the 10th waste fraction, it became evident that weather conditions—particularly cold and rainy periods—can significantly impact textile quality throughout the collection phase. As highlighted in the problem mapping (see Figures 11 and 32), textiles may continue to be exposed to environmental conditions during the delivery phase, depending on contractor facilities and handling practices. The interview findings confirm this, showing that the impact extends beyond initial collection and is closely linked to the level of awareness of critical trigger points for preserving textile quality.Test Municipality 1, which operates its own transport system including drivers, explained that "we now check the weather forecast before collecting, reloading and transporting the textiles.

We experienced that our previous external transporter was driving around with open container gates and an open truck while collecting and only covering the textiles with a half-closed tarpaulin on top of a top-open container when delivering to NewRetex". This illustrates how differences in handling practices—such as leaving containers and gates open during collection, insufficient covering during transport, and operating within partially unsealed reloading facilities—can lead to water accumulation during rainy periods. These findings demonstrate that weather-related impacts are not solely determined by environmental conditions, but are shaped by the interplay between material infrastructure and operational practices across multiple stages of the collection and delivery process. Importantly, it is through my qualitative insights that the relevance of weather as a variable becomes analytically evident.

From my previous design anthropological study, I conducted multiple participatory observations, spending between 3 and 5 hours at different recycling stations. A key observation was that collection workers had a special focus on most other waste fractions, actively identifying incorrect sorting by citizens, while textile waste containers were largely unmonitored. This observation is supported by the findings from my semi-structured interview with Test Municipality 1, where it was explained that this had previously also been the case at their recycling stations. However, they have since relocated textile waste containers next to the hazardous waste fraction, which collection workers are required to monitor. Physically situating textiles within an already monitored space represents a deliberate reframing of textile waste practice as they draw on the existing frame of careful handling and supervision. It is an intervention that strategically borrows the competence and meaning embedded in hazardous waste, reframing textile waste as something requiring similar attention and responsibility. In Dorst's terms, this is a frameshift, where a known practice is recontextualised to address a new problem through association and proximity (Dorst, 2011).

Lastly, the frequency of emptying is identified as a particularly impactful variable, due to its significant variation across cases—from multiple collections per week to intervals of several months. Insights from my field work with industry actors further support this. During a SorTex status meeting, a Swedish waste contractor reported no issues with wet textiles, which was later linked to a high collection frequency of 2–3 times per week. While effective in maintaining material quality, this approach was also described as administratively and economically demanding. In contrast, at a Dakofa conference, WMO 2 highlighted how user patterns—particularly the high share of vacation homes on Djursland—lead to fluctuating loading degrees at recycling stations. As a result, their average frequency of emptying is approximately every eight weeks. These variations illustrate how frequency of emptying is shaped not only by operational decisions, but also by local usage patterns and infrastructural conditions

Correlation Analysis

My qualitative findings indicate that it is valuable to investigate the correlation between variables of weather and frequency of emptying, as this allows for comparison of how the correlation varies across container types and how it relates to qualitative factors such as social practices and demographics.While the use of quantitative data analysis—such as correlation coding in Excel—does not align with traditional anthropological methods, it reflects a core principle of design practice: interdisciplinary collaboration. In design, working across fields and professional areas is essential for developing holistic interventions and generating meaningful design value (Tschimmel, 2012).

The correlation analysis is conducted in collaboration with the Production Development Engineer at NewRetex, using data extracted from the MES system. The Pearson correlation coefficient is applied in Excel, enabling a focus on structuring and preparing the dataset for analysis. The correlation values range from -1 to +1. A low correlation between rainfall and wet textile fractions, combined with a low average level of wet textiles, indicates that the container type and collection method effectively maintain material quality of the textiles. In constrast, a positive correlation between wetness and frequency of emptying might indicate that infrequent or prolonged emptying-intervals contribute to moisture accumulation.. I compiled a dataset including municipality name, delivery dates, Frequency of Emptying (days between batches), container types, total textile waste, wet textile waste, and rainfall for each period and location.

Municipality	Batch ID	Date	Container Type	Wet Textiles (kg)	Total Textile Waste (kg	Rainfall (mm)
Grenå	1605.0	2024-09-26	Gates2	1215.0	3725.0	110.0
Grenå	1678.0	2024-11-14	Gates2	388.0	3180.0	40.0
Grenå	1753.0	2025-01-20	Gates2	692.0	3660.0	120.0
Grenå	1811.0	2025-03-17	Gates2	525.0	3465.0	40.0
Herning	1390.0	2024-05-27	660L	391.0	6765.0	46.0
Herning	1452.0	2024-06-27	660L	361.0	4815.0	94.0
Herning	1489.0	2024-07-30	660L	282.0	3330.0	116.0
Herning	1493.0	2024-07-30	660L	299.0	3442.0	116.0
Herning	1557.0	2024-08-28	660L	539.0	6275.0	128.0

Figure 33: Overview of Data Sheet

The findings are presented in three parts: materiality, container type performance based on correlation analysis, and the optimal combination of municipality and container type. The results show that effectiveness is not determined by container type alone, but by the interaction between container type, local conditions, and frequency of emptying. The “most effective methods” emerge from the interplay between materiality, as evidenced by the quantitative analysis, and the dynamics of social practice.

Findings by Container Type

The 660L container – Test Municipality 1

The 660L container demonstrates the most stable performance. A weak negative correlation (-0.17) between wet and rain, indicates that rain does not significantly increase the amount of wet. However, a slight positive correlation between wetness and frequency of emptying (+0.16) suggests that longer intervals between collections may contribute to marginal increases in wet textiles. The analysis is made based on a sample size of 11 batches.

Shipping Containers with Closed Side Gates – WMO 1

For shipping containers with sealed side gates, a strong positive correlation (+0.62) between wet textiles and rainfall, indicates high sensitivity to rainfall, despite sealing the side gates. In addition, a moderate positive correlation between wetness and frequency (+0.35) suggests that longer emptying intervals contribute to increased moisture accumulation. This indicates that both environmental exposure and operational practices influence performance.

Shipping Containers with Cages

Shipping containers with cages show some sensitivity to rainfall with a weak positive correlation (+0.16), however, still significantly less sensitive to rain compared to "shipping containers with closed side gates", and "open side gates", making them the second least affected container by rain after the 660L containers. A moderate positive correlation between wetness and frequency (+0.30) indicates that collection intervals plays a noticeable role in moisture accumulation. This suggests that while some moisture is introduced through rainfall due to the material design, the impact can be reduced by increasing the frequency of emptying, as operational practices have a stronger effect on wetness than rain sensitivity for this container type.

Shipping Container with Side Gates – WMO 2

Shipping containers with unsealed side gates perform significantly worse, with an average of 34% wet textiles. A very strong positive correlation between wet textiles and rainfall (+0.88) indicates extreme sensitivity to rainfall. In addition, a strong positive correlation between wetness and frequency of emptying (+0.70) shows that long intervals (every 80 days) between collections significantly increase moisture accumulation. This indicates that both the container's exposure to rain and the prolonged frequency of emptying contribute to problematically high levels of wet contamination, with the extended collection intervals amplifying the overall contamination impact. In addition, high levels of wet textiles are also present during periods with limited rainfall, which further proves that the long frequency of emptying independently contributes to moisture accumulation at the batch level. This shows how material limitations of the container design are reinforced by the dynamics of practice, where infrequent emptying amplifies the inherent material sensitivity to environmental conditions.

Container Type	Sample Size	Avg. Wet (%)	Correlation: Wet vs. Rain	Correlation: Wet vs. Frequency	Frequency of Emptying	Analytical Interpretation
660L Container	11 batches (60.447kg)	8%	-0.17 (weak negative)	+0.16 (weak positive)	Variable	Low sensitivity to rain; slight increase in wet textiles with longer emptying intervals
Closed side gates	29 batches (89.395 kg)	11%	+0.62 (strong positive)	+0.35 (moderate positive)	Fixed (~30 days)	High sensitivity to rain; moderate indication that longer emptying intervals increase wet textiles
Shipping Container with Cages	82 batches (233.284 kg)	10%	+0.16 (weak positive)	+0.30 (moderate positive)	Fixed (~30 days)	Some rain sensitivity; moderate indication that frequency may influence wetness
Unsealed side gates	28 batches (97.320kg)	34%	+0.88 (very strong positive)	+0.70 (strong positive)	~80 days	Extremely sensitive to rain; long emptying intervals significantly increase wet contamination

Summary of Correlation Analysis Results

Causation Analysis: Materiality and Practice

Further examination of data at the level of individual recycling stations, as presented in Figure 33, rather than solely compiling container and WMO-level data, reveals important variations in performance. This enables more analytically grounded recommendations regarding container design versus infrastructural and social practices. An individual recycling station within WMO 1 (Test Municipality 2) demonstrates the lowest average wet fraction (7.4%), despite showing a strong positive correlation between wet textiles and rainfall. This indicates that although shipping containers with sealed side gates are highly sensitive to environmental conditions, overall wet levels can still remain relatively low. This proves that, even for containers with higher rain sensitivity, operational practices—particularly the frequency of emptying—play a critical role in determining final material quality. In comparison, Test Municipality 1, using the 660L container, shows limited sensitivity to rainfall and maintains relatively stable wet levels. However, when comparing the two cases, it further proves that performance cannot be attributed to container design alone. The contrast between the two municipalities suggests that lower wet fractions is achieveable with containers that are more sensitive to rainfall, provided that operational practices are optimized. This indicates that improvements in practice can offset limitations in material design, and that the

most effective outcomes arise from the interplay between container type and collection practices. During my semi-structured interview with WMO 1, which covers Test Municipality 2, they shared with me that: “We have had really positive experiences with our collection workers at our recycling station in Test Municipality 2, their engagement stands out in comparison to especially one of our other recycling stations, which is our worst performing recycling station. The collection workers at Test Municipality 2 are very good at going into the container and checking the textiles for any conspicuous wet bags or loose textiles”. This proves that while quantitative data can reveal patterns, correlations, and measurable outcomes, it often lacks context—the why behind the numbers. Design anthropology, through methods such as participatory observation, semi-structured interviews, and interventions, provides deep insights into human behaviour, motivations, practices, and systems of meaning that create those patterns, moving from simply identifying problems to understanding their root causes and designing interventions that are both data-informed and socially grounded. While the high correlation between wet and rain offers a statistical insight, Test Municipality 2 still has the lowest amount of wet textiles — and without anthropological fieldwork, the impact of collection practice, and the potential impact of a new container, could have been dismissed (Maher, Maher, McAlpine, Mann, & Seabrook, 2018). For the last two variables mapped in Figure 32, demographics and user practice (citizens), insights from the Dakofa conference, proved how the variables of city types, space and demographics influence the collection methods used and to the user practice seen. At the conference, an employee from Aarhus’ WMO called Kredsløb, shared how in cities as Copenhagen and Aarhus, there are certain areas reserved for, or eligible for, waste containers. Due to the density of apartment buildings in the big cities and the size of the streets, there are multiple restrictions on container sizes and the types of garbage trucks that can enter the street for unloading. Certain areas in the city centre are likewise reserved for other purposes, as parking, architectural objects like statues or other cultural designs, and there is an aesthetic factor to the space as well. Due to the density of these bigger cities, there is also little space for recycling stations, and the size of the recycling stations is likewise limited, which can hinder the use of a 20-foot shipping container. In addition, due to cities like Aarhus and Copenhagen, as well as Odense and Aalborg being university cities, there is a large number of students and therefore “young people” in those cities, and they have different behavioural patterns compared to older generations. This variation in user practices affects how textile waste is handled and disposed of within the system and demonstrate that both demographics and user practices are context-dependent variables that shape the effectiveness of collection systems, reinforcing the need to account for local conditions when designing and evaluating waste management solutions.

Developing for Better Practices

In this section, I am transitioning from problem exploration to prototyping, development and testing. Along with classification and practice theory, I have drawn on Dorst's design methodology of abduction-2 and the core design practice of frame creation in my approach to explore the current practices and in designing towards better practices within textile waste. According to Dorst, the value in design practice' approach to problem solving lies in the ability to search for the central paradox by looking at what makes the problem so hard to solve and to "not start working toward a solution before the nature of the core paradox has been established" (Dorst, 2011). Also, my problem and concept mapping introduced in the previous section is not meant as a finalised picture of the industry, as mapping is a dynamic process and can therefore never be finished - it is through problem framing that interventions and solutions emerge, you need to understand the complexity of the problem as problems and solutions develop simultaneously in an interplay with each other. Therefore, I will still include problem framing in this section, as through my testing for developments, I have faced problems in the interplay with the development of elements for a proto-practice.

As mentioned, the objective of Work Package 3 of the SorTex project is to analyse the current collection methods and practices, to create a method book with best practices. Similarly, a legislative proposal, which was declared during a Dakofa conference I was attending, wished to streamline the handling process of all waste fractions throughout the 98 municipalities in Denmark. As I have shown by mapping the different collection methods and the variables in the practices, the objective of the best practice method and streamlining the 98 municipalities is working against a wicked problem, trying to reduce complexity instead of looking deeper into the system and the root of complexity. After various status meetings with the steering group behind Work Package 3 of the SorTex Project, it became clear that a best practice method might not exist – what's needed is an analysis of what does not work as much as what does. However, I find it essential to establish a frame of understanding of what a "best practice" method entails, using Shove to analyse the meaning of the term. Across reference sites, the term "best practice" generally refers to a working method, technique or procedure that is, based on research and experience, classified as the most effective practice with the best results and is to be standardised across different contexts to achieve desired outcomes (Cambridge, 2025). I find this terminology and mindset, to be a top-down model way of thinking. I am questioning the scale at which a best practice is implementable in actual practice. Using Shove as a frame of reference, the notion of a best practice fails to take into

consideration the actual lived practices and experiences of the users executing said practices, who are at the “bottom” of the decision-making hierarchy (Shove, Pantzar, & Watson, 2012). The current classification and understanding of a best practice make the user a passive recipient of the methods, instead of an active participant in co-evolving the said practices. It is the users’ interactions with the presented elements by Shove, materials, competences and meaning, that creates the practice, which is why it is essential to find the balance between designing for current behaviours instead of designing towards desired change in behaviour.

Visual Prototyping and Design Interventions

The first activity I conducted in the development phase was part of a brainstorming session with the tender coordinator and production development engineer at NewRetex, where we established the need for a prototyping test of communication designs. We mapped where in the management journey that communication design could potentially impact the quality of the incoming textiles, and more importantly which problem fractions the prototyping could intervene in.

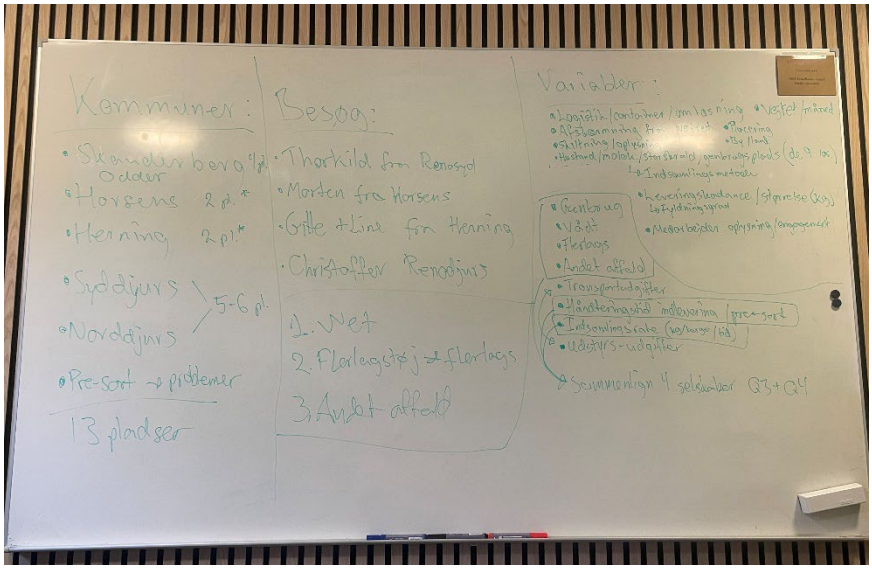


Figure 34: Brainstorm Mapping

As mentioned throughout my mapping, the main problem fractions are the significant amount of wet textiles and other waste fractions, and multi-layer garments being more of a material issue for recycling technologies. During our brainstorming, we conceptualised the key factors influencing each problem fraction, based on my problem mapping. For the wet fraction, the main issue was

linked to material functionality in the collection phase, including container and truck design, as well as the practices of both collection workers and citizens. For the "other waste" fraction, the key factors were the tensions between informal and standardised classification, and an incorrect sense of competence and perceived meaning of the citizens being a potential barrier to participation in proper sorting practice.

Our theory was based on situational conversations from this study and semi-structured interviews from my previously mentioned anthropological study, where I found that many citizens believe that it does not matter how textile waste and other waste fractions are discarded and collected, as it all ends up in the same place, incineration. In addition, in a recent situational conversation with a random citizen at a public garbage site, I was told that “it is meaningless that these containers have different gates when it is just one big container in the ground”, indicating that the container design mixes the different fractions instead of separating them. Therefore, I found that in not sorting according to the standardised classifications or bagging the textile waste properly, a critical factor lies in the meaning element of the practice, as the belief that all textile waste is ultimately incinerated undermines the perceived value of proper sorting and therefore the motivation to engage with the practice as instructed is diminished (Shove, Pantzar, & Watson, 2012). In short, the citizens may see the correct practice as a symbolic effort with no tangible outcome. From Shove’s perspective, this illustrates how practices shift when their core elements become misaligned. Here, the breakdown is not due to the absence of infrastructure or inability to sort, but due to the erosion of meaning — a belief that the system is ineffective or deceptive. Therefore, I decided to design and develop two types of intervention-based prototypes, in the form of physical signs, one to alter the social meaning of textile sorting, illustrating through visual elements how the journey of the discarded textiles does not end in the garbage (or incineration), and one to illustrate the standardised classifications in a more instinctive way to lower the amount of other waste and mis-sorting as according to Shove, innovation in practices requires new skills, new meaning and new materials - developing elements for a proto-practice to form into an integrated practice.

Testing and prototyping is central to any design process – they are vital for research and feedback purposes before fully implementing any design, system or process (Paust & Korsgaard, 2022). Therefore, before initiating the development of the prototypes, as part of my planned participatory observations and semi-structured interviews with the test municipalities, I had a specialised focus on their need and willingness for receiving communication material. The employees at WMO 1

quickly shared that they had been doing some user feedback testing, and through their survey had found that the citizens are missing information about what happens with the different waste fractions after discarding them. Therefore, WMO 1 freely requested communication material from NewRetex regarding the journey of the textile waste. We shared with them that as part of the SorTex project, I was looking into how and where communication can impact the practice of textile waste disposal from the citizen perspective and asked if they would be interested in having signs at their recycling stations and as digital communication. I also had the same specialised focus when visiting both Test Municipalities 1 and 6, and they also requested more communication material, wanting to place visual signs at their recycling stations. Afterwards, I did measures for the signs, using the smallest measurements that could fit all the different solutions at the municipalities, and calculated that we needed to order 12 of each sign.

For the aesthetics of the signs, I followed an existing graphic design style used by NewRetex in prior communication and on their website, using their design guide for fonts, colours and visual elements, adding new elements and colours where needed. In addition, as part of the communication strategy, Work Package 2, in the SorTex project, it was mandated that the Interreg Logo must be included in any visual elements of the project, and that the logo must be at least as big if not bigger than the scale of the project partner's own logo. My exploratory research me to synthesise my research data with my design ideas, using framing of an existing process visualisation by NewRetex, to design my first prototype (Tschimmel, 2012). My extensive fieldwork working with NewRetex meant that I fully understood the process to be able to recreate it.

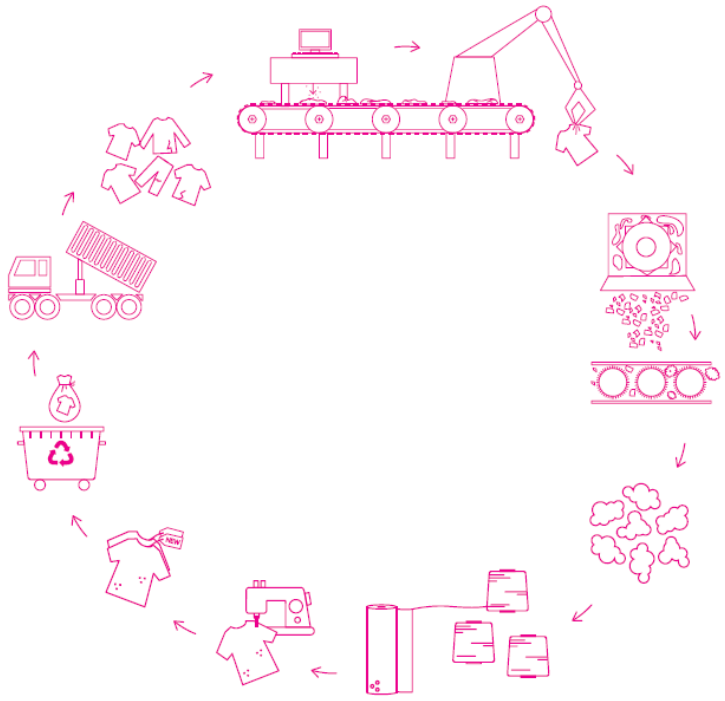


Figure 35: Existing Process Illustration

So, instead of framing textile sorting as a technical process, as seen in Figure 35, I wanted to visualise the embedded practice in a “road journey”, showing how the textile waste moves through the value stream, see Figure 36 below.

Tøjets rejse slutter ikke i skraldespanden!

Interreg
Medfinansieras av Europeiska unionen
Öresund-Kattegat-Skagerrak
New Retex

Figure 36: Journey Visualisation of Textile Waste Process

Figure 36 visualises every step of the textile waste journey through visual elements, from the citizen delivers it, making a "call-to-action" to place it in a sealed bag, through the transportation process and finally the sorting and recycling process at NewRetex. As this sign is meant for NewRetex' collaborating municipalities, it shows NewRetex as the receiving contractor. The initial intended use and receiver of the prototype was the citizens, with the objective of closing the meaning and competence gap, reframing the problem of textile waste ending up in landfills or incineration, instead creating a proto-practice that sees proper sorting not as waste but value and resource creation.

For the second sign, shown in Figure 37, the objective was as mentioned to create a new competence and meaning for the citizens, creating a proto-practice where other waste fractions is not part of the informal and instinctive classification of textile waste, and testing assumptions based on my fieldwork (Paust & Korsgaard, 2022).

Figure 37: Classification of Textile Waste Prototype

For the visual elements I took the sorting component from the journey sign, and changed the design to make the sorting staff look displeased with having to touch other waste fractions than textile waste. From my participatory observation, participating in the pre-sorting at NewRetex for a full shift of 8 hours and finishing a 5-ton batch, I experienced that the sorting staff are forced to touch anything from food waste, dirty diapers, wet and mouldy textiles that smell and therefore disrupts the working environment, to broken glass, syringes etc. also making it dangerous.

Figure 38: Example of Other Waste

Another objective was to test my assumption that if citizens know that people must manually sort through the delivered waste, enhancing their competence, they will emphasise with the sorting staff and change their sorting practice. This assumption was also built on the tender coordinator from NewRetex having had a situational conversation from showing male collection workers the pre-sorting at NewRetex. He shared with me that the collection workers noticed it was women working at the sorting and had then stated that because it was women working at the sorting belt, they collection workers had to be better at removing other waste from the containers and informing citizens, so the women did not have to touch other waste than textiles. The Environmental Protection Agency has already made a bulleted version of a “yes please/no thank you” sign, however, I want to test my assumption that the visualisation of the classified objects will enhance the competence element of the citizens practice, simply by them noticing the sign, as the visuals will create a better immediate understanding.

For the “yes please/no thank you” section of the sign, it visualises frequent reoccurring non-textile objects like mattresses, cushions, teddy bears, shoes, bags and then of course also wet textiles. Both in my participation in the pre-sorting, and throughout my entire fieldwork at NewRetex, I experienced a significant amount of mattresses and cushions, the tender coordinator likewise confirming it is a big issue they have. The standard classification mandates that mattresses and cushions are “non-textiles”, however, the informal and instinctive classification of citizens focuses on the exterior of the objects, which is fabric.

Figure 39: Example from Batch

Lastly, I am a big advocate for using visual messages rather than text – using it only as support – as research in human cognition and consumer thinking shows that visuals stimulate “immediate visual understanding” and captures attention and trigger comprehension fat least 600 times faster than text. The exact science has not been established; however it has been established that text has a slower process of comprehension compared to visuals, and that it trigger a higher information recall (Huber, 2017).

Lastly, as mentioned I learned from the SorTex conference in April, that shoes would now be classified as textile waste, whereas it was previously classified as residual waste or second-hand. This also confirms Bowker and Star’s argument that classifications are never complete which also creates tensions in practice (Bowker & Star, 2000). The tension then being illustrated in the

classification prototype I designed, which portrays shoes as being “no thank you”, which also enhances the importance of prototyping as Paust and Korsgaard states that: “Prototypes based on the function and purpose we try to fulfill – not just about the prototype as an object but the entire process around the use of it” (Paust & Korsgaard, 2022).

The initial intention for the prototype testing, was to test how communication at the “point of delivery” can impact primarily the other waste fraction, wet and the collection rate at the agreed recycling stations from the test municipalities. Using NewRetex’ MES traceability system, the signs would be placed during Q2 2025 (April, May and June) to ensure the same basis of comparison, comparing with Q2 for 2024 to locate changes in the data. Two weeks after agreeing with the test municipalities, I announced at the Dakofa conference that the signs were ready for implementation, however all the municipalities shared they currently lacked physical space to display them. This was an unforeseen challenge as the size had been agreed together with them. The response highlighted that prototyping is not only a means of testing solutions but is also a diagnostic tool that reveals unforeseen restrictions and contextual alignments - what initially appeared to be a resolved step in the design process revealed new barriers upon real-world engagement (Tschimmel, 2012).

Figure 40: Picture from NewRetex

Intervention into Professional Practice

As a responsive adjustment, we recontextualised the prototype by placing the signs at NewRetex—in the delivery hall and pre-sorting area (see Figure 40). Prototyping is an essential step in the design process as the circumstances you are designing for, can change rapidly in a highly complex industry such as textile waste management and as problems and solutions develop simultaneously in interplay, this simply re-framed my research approach and the "focus group" changed from being how it impacted the citizens to how professionals in the industry related to it. The re-framing of the newly faced problem emerged from an already planned intervention into the practice elements of the collection workers from Test Municipality 1 – including both staff from the recycling stations and those collecting from households. The intervention emerged and was agreed to during my ethnographic visits to the test municipalities, however, Test Municipality 1 showed the greatest interest and effort in participating in a "training tour" as they operate their own logistics system and does not outsource

transportation to an external contractor. Likewise, Test Municipality 1 is a key partner in the SorTex project. As mentioned in mapping the variables, there can be a significant difference in the practices of collection workers between the different recycling stations within the same WMO, as seen with WMO 1. In addition, NewRetex has previously had other municipalities visit their facility and found that the engagement level of the workers is extremely varied. As mentioned, the practices of the collection workers during the collection process have a great impact on the end quality of the textiles collected. Using Shove's theory of the Dynamics of Social Practices as a conceptual framework, the intervention attempts to introduce and promote a "proto-practice" – an early-stage, emerging routine aimed at reshaping the existing practice of textile waste handling. The training intervention targeted competence and meaning dimensions (Shove, Pantzar, & Watson, 2012). Test Municipality 1 operates 9 recycling stations, so the training sessions were distributed across five separate days. While the intervention is small-scale and exploratory, the desired value is to potentially engage bottom-up practice transformation, laying the foundation for consistent and quality-conscious textile waste handling through a shared understanding of purpose. The training sessions were conducted as a guided facility tour, guiding each team through each step of the handling journey at NewRetex, out of which I conducted 2 of them.

All the tours began at the delivery of textiles, where the participants learned the importance of a dry and acclimatised environment for receiving, and how NewRetex weigh in each batch to ensure traceability. My first tour with one of the recycling stations, one participant noticed my emphasis on "dry" and asked if they should only schedule delivery on "dry days" as it is the transporters scheduling the day of delivery - already indicating an enhanced level of understanding and meaning. Two of the collection workers noticed the classification sign hanging in the delivery hall, and took pictures of it, saying "we need that at the recycling stations", and the other replied "yeah or maybe on the transport truck too, that should be everywhere, we can find many options for it". They shared that the sign was impactful and asked if the signs were something we sold. They thought it was clear that it was actual people handling the textile waste, and that they were not happy with what they were touching, as well as the classification being easily noticeable. However, at my second tour, one of the workers from a different recycling station shared that if "If you depict or convey in any type of way, that the textile waste will go through a manual sorting or any type of sorting, citizens won't care as much about sorting it correctly - they will use it as a way to declaim any type of responsibility". This was an interesting difference in perceived meaning between the two recycling stations, as they attached a different symbolic and social significance to the same

visual interventions – their contrasting views illustrating how meanings within a practice are shaped by experiences (Shove, Pantzar, & Watson, 2012).

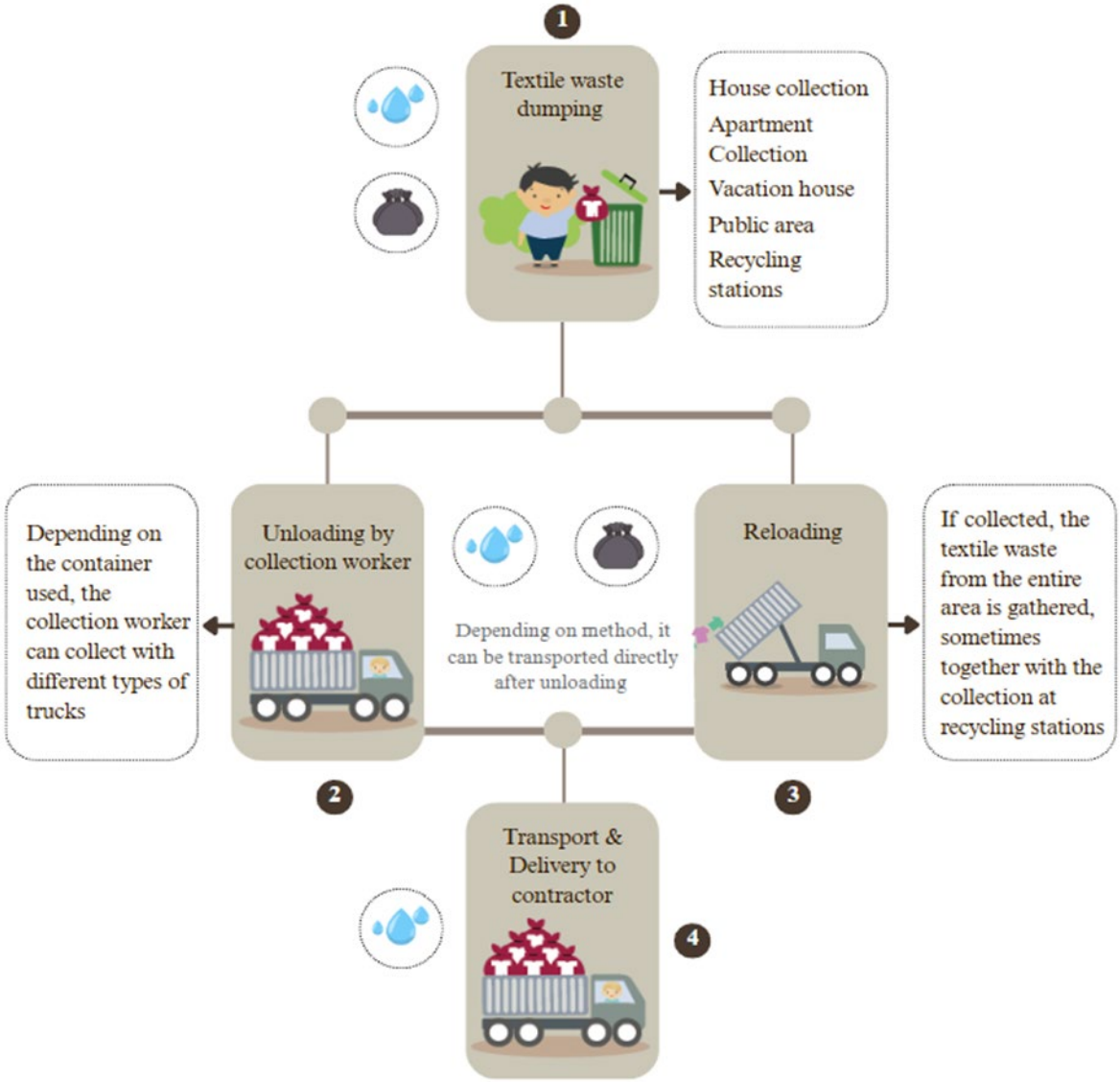
The next step was the pre-sorting, where I shared how all the textiles are first sorted by hand and how it is sorted according to the waste hierarchy, re-use, wet and dirty textiles, other waste and multi-layer before the remaining textile continues into recycling. The employees at the pre-sorting engaged actively in sharing their experiences with receiving food waste and other types of waste. At one of the tours, the collection workers did not know that we sorted to re-use, thinking everything got sent directly to recycling, with most of the collection workers across the tours being surprised that there was a manual sorting. Multiple collection workers shared that it was educational to see what the pre-sorting classified as "other waste", so that they could get a specialised focus on what to look for in the containers to help remove it before it gets delivered. Since the journey sign was positioned by the pre-sorting, multiple collection workers took pictures of the sign, saying: "This would help tell the citizens the good story of how sorting correctly can make their waste a resource again, as it can be difficult to paint a picture only with words".

In addition to the collection workers from Test Municipality 1 visiting, NewRetex had the Danish Environmental Minister visit for a guided tour. He was likewise led through each step and did some participatory observations himself by participating in the pre-sorting. It became a small workshop for him, with the owner, tender coordinator, production development engineer and me showing him around, while he immersed himself in each step. When we walked past the journey sign, he asked his assistant to take a picture of it too, simply stating that it is a good way of illustrating the process of textile waste. Through the tours and the re-framing of the visual prototyping, I experienced a "natural" demand for the signs and the information and meaning they offer simply through the visitors taking pictures of the signs, as it shows that it does capture attention, which allows me to refine the prototypes based on the feedback from professionals, e.g. whether a sorting step should be included, hoping that it too will capture the attentions of the citizens.

Designing the Collection Method

The application sent by SorTex to Interreg states that the “end-product” of Work Package 3 is a “best practice method book”; however, I have chosen to reframe the functionality of the desired end value to fit a more design-appropriate approach for my thesis. Using Dorst framework for the application of design thinking and reasoning, a method book is at the intersection of research and action, emerging from design research projects as an output that translates field insights, empirical data and tested prototypes into an applicable format (Dorst, 2011). A method book documents the transformation from fieldwork to design intervention, including tools like journey mapping.

My overall stance is that it doesn’t help to simply present a prescriptive tool with interventions and suggestions if the receiver of the methods does not fully understand “their role” in the problem that they are trying to solve – meaning that the municipality need to map their problem areas before they can look into a “method book” to find what interventions suit their specific problem area. Designers are problem finders as much as problem solvers. To solve a problem, the problem needs to be fully mapped and understood, otherwise, you might solve the wrong problem (Tschimmel, 2012). Say that a municipality changed containers to the “best one”, but their water issues were not at a material level, but a practice level, their collection workers needed training and not a new container. It need to allow municipalities and practitioners to co-create their solutions by following a structured but flexible framework.

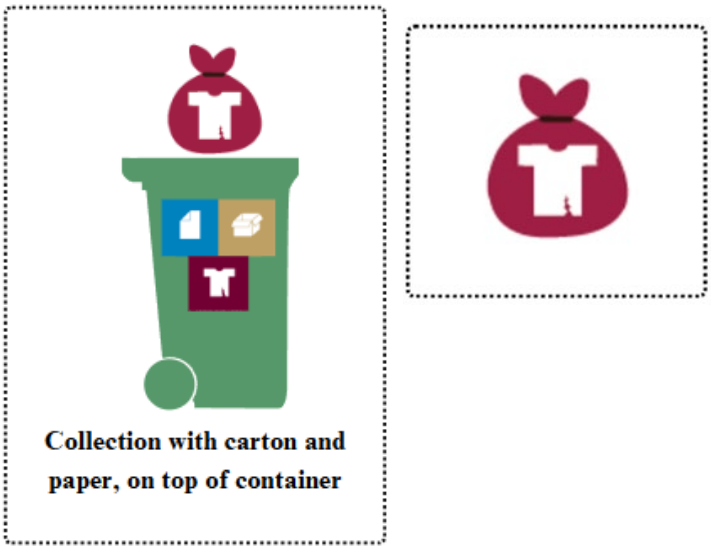


Using my problem mapping design of the collection process as inspiration to a potential design probe, I argue that the first phase before going through a step-by-step synthesis, is to invite the individual municipality to fill out the process map in collaboration with their contractor, NewRetex in this case, to map where they are exposed to the problem fractions – for WMO 2, they are using highly rain-sensitive containers, and can therefore map that a great impact happens at Step 1, whereas for municipalities using low sensitivity containers, the exposure happens either in other steps of the collection process or it is on a practice level. It invites each municipality to map their own processes and practices in each step, to understand the complexities and dynamics in each problem area, making them ask, “Are we choosing the right solution for the right problem?”. (Paust & Korsgaard, 2022)

Step 1: Textile Waste Dumping

For the problem fraction “other waste”, it is primarily waste fractions like food waste, dirty diapers, glass and other sharp objects, etc. that pose a risk for contamination of the textiles – but it is important not to look at the isolated quantitative data as the final indicator, as localised classifications differ. As mentioned, from my 4-month-long fieldwork with NewRetex, I found that half of the other waste classification is non-contaminating, meaning that it is simply not recyclable e.g. sequinned clothes. In addition, as per the DEPA and the specification requirements I have received from the WMO, shoes used to be classified as other waste, but they will now be classified as textile waste. Therefore, the combined value of the collection method is primarily decided based on the amount of wet clothes.

Pick-up Scheme



For the pick-up scheme at house collection, it is the 220L with the textile waste inside the container with paper and carton that, based on our test batch, has the lowest amount of wet with 0%. However, talking with the Advisory Board and the tender coordinator at NewRetex, we agreed that the sample size is insufficient and requires more tests, also due to the low amount of textiles present in the batch, 133kg out of 2.045kg. So, out of the tested collection methods for the pick-up scheme, the 220L container with textile waste collected on top of the container has the lowest percentage of wet with 16%, however, with 30% other waste. In addition, as with all the collection methods, the municipality has to provide its citizens with bags.

Recycling Stations

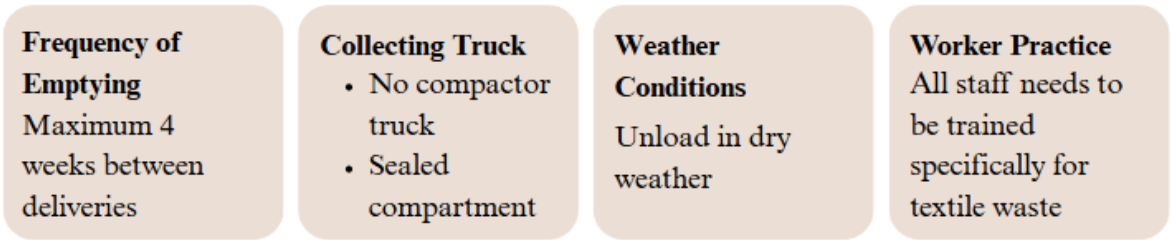
10/20 feet shipping container

660L containers

For the current “best container”, for recycling stations,, it is the 20 feet shipping container as it has the best mix for the amount of wet and other waste with 10% wet and 15% other waste, also it has a low sensitivity for rain with no correlation between amount of rain and wet. The container with the lowest amount of other waste is the shipping container with side gates, with 11%, however, it has 34% wet and a high sensitivity for rain. The 20-foot shipping container is the best solution that is currently available for recycling stations that have the space. If a recycling station does not have space for the shipping container, the second best is the 660L container, with 8% wet, given that they have a roof or a type of cover for it; however, it has a high amount of other waste, with 21%.

As indicated by the textile waste bag illustration, it is important for all collection methods that the municipalities provide the citizens with bags and encourage them to dispose of their textile waste in sealed bags, having them available at the recycling stations as well as at the homes.

Step 2: Unloading



For the unloading step, four elements are key to improving textile waste quality: (1) a maximum Frequency of Emptying of every 4 weeks, (2) sealed, non-damaging collection trucks, (3) unloading in dry weather, and (4) proper handling practices by transport workers. In two out of the four specification requirements I received, one stated "we do not commit to delivery in a consistent flow" and another that "we commit to delivery with a maximum of 6 months intervals". However, my correlation analysis shows a direct correlation between the Frequency of and the amount of wet, with the best results occurring at 4-week intervals or less. Across all specification documents, responsibility for textile quality is placed on the contractor at delivery, meaning the WMO is accountable throughout the collection process. This setup clashes with requirements that no more than 15% of the batch be incinerated. Therefore, the specification requirements must be adjusted to reflect shared responsibility and clearer quality standards.

Our test batch that had used a compactor truck demonstrated its unsuitability—it damaged plastic bags and tore open textiles and pillows. Textile waste requires gentle handling, ideally in sealed trucks to protect against rain. This links directly to collection workers' practices: whether internal or outsourced, they must be trained to understand the vulnerability of textile waste. Practices like leaving gates open during rain directly impact quality, revealing a need to raise both competence and meaning in Shove's terms. Finally, scheduling unloading during dry weather is essential. It would be impactful to include a note in the specification documents that if poor weather delays collection beyond 4 weeks, the WMO must notify the contractor and reschedule for a dry day.

Step 3: Reloading

The reloading step is a variable between unloading and transportation. Not every municipality reloads, either because they do not have a reloading station, or they use the recycling station to reload the batches of house-collected textiles with the recycling station's batches. There are two important elements for municipalities' reloading. One, it needs to be either during dry periods if there are no recycling stations, followed by immediate transportation or in a closed, dry and indoor station, where citizens cannot access. Two, when reloading, the collection workers have to be trained in the vulnerability of textile waste, using this opportunity to remove any larger objects that are “other waste” and other contained, wet or heavily dirty textiles. As seen with Test Municipality 2's recycling station, which uses a container highly sensitive to rain, the practices of the collection workers, with their high knowledge and engagement, bring down the amount of wet.

Step 4: Transport and Delivery to the Contractor

For the transportation, like with all other steps, the the staff must be trained in handling textile waste, so that e.g. all gates are closed during transport, and so that, as mentioned in the intervention with the training tours of the collection workers from Test Municipality 1, they know to check the weather

forecast to try and schedule delivery on a dry day. Furthermore, in the specification requirement, it needs to be specified that a conveyor belt is required as it is only in two of the four specification requirements I received as per my design intervention, that mentions “conditions that keep the textile waste dry” or “ensure that it is received in a dry and covered environment to avoid moisture”. An actionable and implementable step is for a more specific requirement, one; the textile waste must be received in a closed-off area, that is completely covered, dry and acclimatised. Additionally, none of the four specification requirements mention a conveyor belt, but all of them require that the delivered textile waste is weighed in using a certified weight, but it is not specified how it has to be weighed.

Discussion

Through my meetings with the SorTex steering group for Work Packages 3 and 4, I learned that in Sweden, they have a one-stream solution, meaning that there is no differentiation in classification between textile waste and clothes for reuse in practice for the citizens as they are using one container and are not using any classifications for what can come into the container. However, from the SorTex conference in Herning in April, where multiple actors from different tiers of the value chain were present, including representatives from Swedish municipalities and textile sorting companies, the Swedish SorTex project leader shared that the Swedish NGO's wants a two-stream solution as we have in Denmark, as they have the impression that it will provide them with more clothes. In Denmark, we are experiencing NGO's calling for a one-stream solution so that all clothes sorted for re-use can be sent directly to their second-hand stores. During the Advisory Meeting, the representative from the DEPA shared that the EU Commission is voting for a one-stream solution as they believe that the citizens cannot "be trusted" with the responsibility to sort according to the standardised classifications for second-hand and textile waste. Seeing how classifications are never complete, and with the continuous changes in what is classified as textile waste, this could remove the confusion for the citizens and hopefully make them perceive the disposal of used textiles as being easier. While a one-stream system could potentially reduce the confusion for citizens, it is important to note that the problem fractions that are currently other waste and wet textiles are not just rooted in the tensions in the classification system, but more deeply rooted in the practice of citizens, particularly at the meaning level (Shove, Pantzar, & Watson, 2012). Transitioning to a one-stream solution without addressing the citizens' understanding and motivation factors will not remove the other waste and the contamination – this still requires interventions in the perceived meaning of sorting correctly, otherwise we risk the same issues persisting under a new system.

Conclusion

This thesis paper has investigated how I might design collection methods that improve the reuse and recyclability rates while reducing wetness across diverse municipal contexts. And sought to understand and present how the interplay between material design and social practice impacts the level of wetness and contamination of textile waste. Drawing on the framework of design anthropology, and practice and classification theory, my research has combined insights from qualitative fieldwork with quantitative data analysis, incorporating collaboration between professional fields, to offer a holistic and thorough response, recognising that textile waste collection is not a fixed system but a complex and shifting practice. Throughout my research process, using problem exploration as a key method, I have established that no current collection method, used in isolation, can contribute to a higher reuse and recycling rate. My research has proved that the value of improved textile waste quality is found in the interplay between the material design and social practice throughout the entire value stream. As with all wicked problems, it cannot be solved in isolation; all steps of the process have to work together, as with Shove's elements of practice. Practices such as whether citizens use sealed bags, whether gates are left open, or whether textiles are handed in wet are shaped by meaning, competence, and material (Shove, Pantzar, & Watson, 2012). My correlation analysis showed that for two of the containers, 660L containers and 20-foot shipping containers, there is little to no correlation between rain and the amount of wet, meaning they have low material sensitivity, which indicates that it is the individual practices around the collection, that influences the amount of wet. In contrast, the containers with side gates having a high correlation between rain and the amount of wet, being highly sensitive to rain, could still produce low amounts of water exposure, due to the practices of the collection workers.

As mentioned, the expected results concerning the SorTex project were to establish a guided overview of what does and doesn't work in certain contexts. However, my thesis has shown that the "final product" consists just as much of creating understanding of the complexities and dynamics of problem explorations as problems and solutions develop simultaneously in an interplay with each other – learning to ask the question, are we designing the right solution to the right problem? The same applies to the desire to create streamlined solutions across municipal and Nordic borders, as my findings also show that context-specific challenges, such as differences in weather exposure or citizen sorting habits, require that solutions be adapted locally, not standardised across

municipalities and countries. Furthermore, my problem mapping found that the lack of transparency, willingness to collaborate, lack of compliance with documentation, and the inadequate inspection of collection and sorting facilities are discouraging towards a streamlined “best-practice”. My section “Designing the Collection Method” is a design synthesis of actionable insights in every step of the collection process, presenting the best-case scenarios demonstrating where positive outcomes occur in the interplay between material design and social practice. My conclusion is not a fixed method, but a call for an iterative connection between material infrastructure, institutional responsibility, and everyday practice for both professionals and citizens. As long as practice remains dynamic, design must remain iterative and collaborative. The future of textile waste collection is not based on finalised systems, but on systems that respond to the contemporary realities of practice and are open to being re-designed again and again. As the SorTex project runs until 2027, I present my product as the groundwork for iterative testing and analysis. In addition, this thesis also produced physical products, visual prototypes in the form of signs, which were applied as interventions, initially towards influencing citizens’ practice and instinctive classification, but became part of an ongoing iteration process for a toolkit for municipalities aiming to improve textile waste collection and sorting.

Bibliography

Borger. (2025, January 21). *Offentlighed i forvaltningen.* Retrieved from Borger.dk: https://www.borger.dk/samfund-og-rettigheder/Offentlighed-i-forvaltningen

Bowker, G. C., & Star, S. L. (2000). *Sorting Things Out: Classification and its Consequences.* Massachusetts: The MIT Press.

Cambridge. (2025, April 5). *Best Practice*. Retrieved from Cambridge Dictionary: https://dictionary.cambridge.org/dictionary/english/best-practice

Circulose. (2025, March 26). *About*. Retrieved from Circulose: https://circulo.se/en/project/tommy-hilfiger-%e2%80%95-circulose/

Cross, N. (2006). *Designerly Ways of Knowing.* Springer.

DMI. (2025, April 8). *Månedens, sæsonnens og årets vejr*. Retrieved from DMI: https://www.dmi.dk/vejrarkiv/manedens-sasonens-og-arets-vejr/tabeller-maned

DMI. (2025, April 28). *Månedsoversigt* . Retrieved from DMI: https://www.dmi.dk/fileadmin/user_upload/Afrapportering/Maanedsoversigter/Oversigt_2025_marts.pdf

Dorst, K. (2011). The Core of "Design Thinking" and its Application . *Design Studies*, pp. 522-532.

Drazin, A. (2020). Why should anthropology and design engage. In A. Drazin, *Design Anthropology in Context: An introduction to design materiality and collaborative thinking* (pp. 15-44). N/A: Routledge.

Energistyrelsen. (2025, May 20). *Find virksomhed.* Retrieved from Energistyrelsen: https://affaldsregister.ens.dk/Search.aspx?s_comp=&s_cvr=&s_country=0&s_region=0~0&s_rtv=0&s_fraction=19&s_vat=&s_sis=False&s_pagesize=20&s_currentpage=6

EU. (2024, March 21). *The Impact of Textile Production and Waste on the Environment* . Retrieved from European Parliament:

https://www.europarl.europa.eu/topics/en/article/20201208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographics

EU. (2025, Februrary 18). *Commission welcomes provisional agreement to enhance the circularity of textiles and reduce food waste.* Retrieved from European Commission : https://ec.europa.eu/commission/presscorner/detail/en/ip_25_548

EU. (2025, March 1). *Waste Framewrork Directive.* Retrieved from European Commission: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

Huber, A. M. (2017). Visual Storytelling. In A. M. Huber, *Telling the Design Story* (pp. 1-29). N/A: Routledge.

Litster, G., Cardoso, C., & Hurst, A. (2024, November 12). Analyzing problem framing in design teams: a systems mapping approach. *Cambridge University Press*, pp. 1-16.

Maher, R., Maher, M., McAlpine, C. A., Mann, S., & Seabrook, L. (2018, May 25). Overcoming Barriers to Sustainability by combining conceptual, visual, and networking systems Overcoming Barriers to Sustainability by combining conceptual, visual, and networking systems. *Sustainabillity Science*, pp. 1357-1373.

Maiti, R. (2025, January 20). *The Environmental Impact of Fast Fashion, Explained.* Retrieved from Earth . Org : https://earth.org/fast-fashions-detrimental-effect-on-the-environment/?utm_source=chatgpt.com

Management of used and waste textiles in Europe's circular economy. (2025, May 5). Retrieved from European Environment Agency: https://www.eea.europa.eu/publications/management-of-used-and-waste-textiles#:~:text=Door,both%20collection%20volumes%20and%20quality

Miljøstyrelsen. (2025, Februrary 3). *Klassificering af Affald* . Retrieved from Miljøstyrelsen : https://mst.dk/erhverv/groen-produktion-og-affald/affald-og-genanvendelse/klassificering-af-affald

Mogensen, H., & Dalsgaard, H. O. (2018). Mogensen, H. O., & Dalsgård, A. L. (2018). At være til strede: Deltagelse og observation. In. In H. O. H. Bundgaard, *Antropologiske Projekter: En* (pp. 163-180). N/A: Samfundslitteratur.

Munkholm, L., Christensen, B. S., & Christensen, A. C. (2023, Marts). Indsamling og håndtering af tekstilaffald i kommunerne: Resultater fra Miljøstyrelsens spørgeskemaundersøgelse 2022. *Miljøstyrelsen*, pp. 4-20.

Murphy, K. M. (2016, July 29). Design and Anthropology. *Annual Review of Anthropology*, pp. 433-449.

NewRetex. (2025, April 2). *Om os.* Retrieved from NewRetex: https://newretex.dk/om-newretex/

Otto, T., & Smith, R. C. (2013). Design Anthropology: A distinct style of knowing. In T. Otto, & R. C. Smith, *Design Anthropology: Theory and Practice* (pp. 1-29). N/A: Bloombury Academic.

Paust, S., & Korsgaard, S. (2022, March). Prototyping - a guide for entrepreneurs. *Research Gate*, pp. 3-19.

Poistotekstiili. (2025, Februrary 17). Retrieved from Kymenlaaksonjate: https://www.kymenlaaksonjate.fi/jatehaku/poistotekstiili/

Preworn. (2025, May 14). *Grades Of Used Clothing Bundles In The Uk.* Retrieved from Preworn Wholesale: https://prewornwholesale.com/pages/grades-of-used-clothing-bundles-in-the-uk?srsltid=AfmBOoqA2CA40n4MgG8Fa4ixnfjrNTk9OBEEZsfgKyij1IFa4mZn178N

Retegi, J., Ibarra, D., & Igartua, J. I. (2025, January 1). Assessing the sustainability of industrial value chains in Europe: a mapping method proposal. *Production and Manufacturing Research*, pp. 1-27.

Rubow, C., & Bundgaard, H. O. (2018). Introduktion. In H. Bundgaard, & H. O. Mogensen, *Antropologiske Projekter: En Grundbog* (pp. 9-18). N/A: Samfundslitteratur.

Rytter, M. &. (2018). Rytter, M., & Olwig, K. F. (2018). At snakke om det: Måder at interview på. In H. In M. &. Rytter, *Antropologiske Projekter: En grundbog* (pp. 181-194). N/A: Samfundslitteratur.

Shove, E., Pantzar, M., & Watson, M. (2012). Making and Breaking Links. In E. Shove, M. Pantzar, & M. Watson, *The Dynamics of Social Practice:Everyday Life and How it Changes* (pp. 21-42). Sage Books.

Skov, M., Sandler, D. H., Finderup, J., Rasmussen, I. S., & Larsen, R. N. (2023, April). Analyse: Økonomiske og miljømæssige konsekvenser ved at indføre et udvidet producentansvar for tekstilproducenter. *Miljøstyrelsen*, pp. 5-51.

SorTex. (2024). *Ansøgning til Interreg ØKS Projekt* . N/A: Interreg.

SorTex. (2025, March 4). *Udvikling og test af metoder til udnyttelse af tekstilaffald i Danmark og Sverige*. Retrieved from Sortex Projekt: https://www.sortexprojekt.org/

Spradlin, D. (2012, September). *Decision Making and Problem Solving: Are you solving the right problem?* . Retrieved from Harvard Business Review: https://hbr.org/2012/09/are-you-solving-the-right-problem

Stahel, W. R. (2019). *The Circular Economy: A User's Guide* . London: Routledge.

TextileExchange. (2024). *Materials Market Report.* N/A: Textile Exchange . Retrieved from https://textileexchange.org/knowledge-center/reports/materials-market-report-2024/?utm_source=chatgpt.com

Tschimmel, K. (2012). Design Thinking as an Effective Toolkit for Innovation. *Action for Innovation: innovating from Experience* , pp. 1-20.

UN. (2025, May 1). *Fashion's tiny hidden secret.* Retrieved from UN Environment Programme: https://www.unep.org/news-and-stories/story/fashions-tiny-hidden-secret?utm_source=chatgpt.com

Watson, D., Trzepacz, S., & Pedersen, O. G. (2018, Juni). Kortlægning af tekstilflows i Danmark. *Miljøstyrelsen*, pp. 4-65.

Zeuth, S. (2025, March 26). *Fashion Dumpsite: Your Clothing Becomes Their Trash.* Retrieved from Fashion Dumpsite: https://fashiondumpsite.com/

Annex

Classification Sign Prototype

Journey Sign Prototype

Interreg
Medfinansieras av Europeiska unionen
Öresund-Kattegat-Skagerrak
New Retex

Pictures from the SorTex Conference


Mette
Kirk
NewRetex
BÆREDYGTIG
HERNING

Pictures from Dakofa Conference