Artificial Intelligence for Sustainable Societies

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Collective Intelligence in Socio-Technical Systems

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1.0 Executive Summary

Problem Statement

Estonia's textile industry faces a circularity paradox: despite strong environmental values and an established second-hand infrastructure ecosystem, 60-70% of donated textiles fail to re-enter local circulation.

Our Approach

Through Actor-Network Theory (ANT) (Law, 1992)[1] mapping, Value Sensitive Design (VSD) (Friedman et al., 2017)[2], contextual inquiry (Raven and Flanders, 1996)[3] through stakeholder interviews (Uuskasutuskeskus, Humana), and a survey of 35 residents of Tallinn, we identified the critical bottleneck where and why textiles drop out of circularity.

Key Findings

1. **Quality crisis:** organizations receive significant unsuitable donations; donors lack clear guidance on acceptable donation quality
2. **Infrastructure gap:** 30% of survey respondents cite inconvenient donation points as barriers
3. **Operational inefficiency:** single-use plastic storage bags contradict sustainability goals and increase operational costs

Proposed Solutions

We propose a phased, multi-stakeholder intervention strategy as explained below.

Immediate Actions (0-6 months):

1. **Quality guidance system:** informational posters at donation points and student influencer campaigns clarifying acceptable donation standards
2. **Pilot donation bins:** at universities and dormitories to address infrastructure gap for high-motivation, underserved student population

Medium-term Actions (6-12 months)

3. **Weekly mobile donation collection** in underserved neighbourhoods.
4. **Sustainable storage pilot:** replace single-use plastic bags with reusable Ghana Must-Go bags at sorting facilities

Expected Impact

1. **Reduction** in contaminated donations requiring disposal
2. **Increased** student donation frequency
3. **Cost savings and increased sustainability in line with the circular economy goals** through reusable storage

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[1] Law, J. Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. Systems Practice 5, 379–393 (1992). https://doi.org/10.1007/BF01059830

[2] Friedman, B., Hendry, D. G., & Borning, A. (2017). *Value Sensitive Design: Shaping Technology with Moral Imagination*. MIT Press. Retrieved November 18, 2025 from https://mitpress.mit.edu/9780262039536/value-sensitive-design/

[3] Raven & Flanders (1996). Using contextual inquiry to learn about your audiences. https://dl.acm.org/doi/epdf/10.1145/227614.227615

Conclusion and Next steps

These interventions address immediate systemic challenges that prevent full circularity within Tallinn's textile ecosystem. We recommend the City of Tallinn pilot the student-area donation bin initiative in collaboration with Uuskasutuskeskus and Humana. Future research should examine upstream consumption patterns with the aim of behavioural changes to complement these re-use focused solutions.

2.0 Task Distribution and Responsibility

Team Member	Task/Responsibilities
Victor Alves Da Silva Sales	Desk research on circular textile systems, co-development of problem formulation, involvement in solution ideation and slide preparation.
Kendi Njeru	Research on Estonian textile stakeholders, lead construction of the textile pipeline and actor-network map, coordination of communication with Humana and Uuskasutuskeskus, field-note synthesis,
Ruth Acolatse	Background research on the Estonian textile industry, field visit observation and note-taking at Uuskasutuskeskus, and co-creation of solution concepts, authored the executive summary, contextual inquiry chapter, the Value Sensitive Design chapter, co-authored the meeting notes and ANT

3.0 Introduction

3.1 Background and Context

The Textile Challenge is part of the Collective Intelligence in Socio-Technical Systems course at Tallinn University. The project explores how socio-technical systems thinking and collective intelligence can be applied to promote circularity and sustainability within the textile sector in Estonia.

Our team, AISS Spice, selected the challenge focused on textile reuse and waste reduction, working with stakeholders such as Uuskasutuskeskus (Reuse Center) and Humana who are key actors in Estonia's second-hand ecosystem. Through field visits and interviews with these organisations, we examined how donated textiles move through the system, which fractions are reused locally, and which are exported or become waste.

The broader context is that the Estonian textile sector contributes 3–5%[4] of industrial sales and employs a notable share of the industrial workforce, yet a large proportion of textiles still end up in landfills or incineration due to limited recycling capacity and fragmented management of textile flows. At the same time, Estonia is preparing for EU requirements on separate textile collection and extended producer responsibility (EPR) policy[5], which will put additional pressure on municipalities, NGOs and producers to handle post-consumer textiles more sustainably.

The goal of this project is to identify where and why textiles fall out of circular loops in Tallinn, and to investigate how collective approaches, combining human, organisational and technological actors, could improve reuse and reduce the volume of textiles that end up in mixed waste. The project aligns with SDG 12: Responsible Consumption and Production, especially in relation to extending product lifecycles, supporting reuse practices and minimising waste generated per capita.

[4] Eesti Rõiva- ja Tekstiililiit (n.d). About ECTA. Retrieved November 10, 2025 from https://www.textile.ee/en/about-ecta/

[5] Ministry of Climate (July 18, 2025). Extended Producer Responsibility. Retrieved November 10, 2025 from https://kliimaministeerium.ee/en/extended-producer-responsibility

3.2 Problem Statement

Despite Estonia's well-developed second-hand sector and high environmental awareness among residents, a significant proportion of textiles still exit circular reuse pathways prematurely due to infrastructural barriers, unclear donation guidelines, and operational constraints faced by reuse organizations. This results in increased textile waste, financial burdens on NGOs, and missed opportunities for circularity as Estonia prepares for EU textile collection mandates.

3.3 Objectives

Our project objectives developed gradually as our understanding of the textile system deepened. We entered the project with a broad interest in circularity, but through fieldwork, conversations, and system mapping, our objectives became more concrete and grounded in the realities faced by reuse organisations.

Below are the core objectives that guided the project:

1. To understand how textiles move through Tallinn's reuse ecosystem:

We aimed to identify the main actors involved in handling post-consumer textiles, the infrastructures they rely on, and the conditions under which textiles remain in circulation or become waste. This system-level understanding is necessary before any intervention can be meaningfully proposed.

2. To learn directly from reuse organisations about their day-to-day challenges:

The visit to Uuskasutuskeskus and our interview with Humana were central to this objective. These conversations helped us see how sorting work is organised, what types of donations create problems, and how labour, time, and storage constraints shape what NGOs are able to do in the Estonian textile ecosystem.

3. To identify the most significant barriers to textile circularity:

These barriers turned out to be interconnected: quality of donations, the physical work of sorting, limited infrastructure, waste management fees, and the impact of low-quality fast fashion. Understanding how these challenges interact helped us avoid overly simplistic solutions and or problem solution mismatches.

4. To generate and explore early intervention ideas:

Our goal was not to produce a final, polished solution but to develop grounded, realistic directions that could later be refined. These emerged from the needs we heard during fieldwork and were shaped by both practical and value-driven considerations.

5. To align our findings with Tallinn's upcoming policy obligations:

Because the city is preparing for EU requirements on textile collection and EPR (Extended Producer Responsibility), it was important that our work contributed to conversations already happening around circularity and waste management.

3.4 Problem Context and Analysis

The textile challenge presented to us by the City of Tallinn centres on a clear tension: although Estonia has a well-developed second-hand sector and a culture that supports reuse, a large share of textiles still end up in mixed waste streams or are exported as low-value material. Organisations such as Uuskasutuskeskus and Humana play an important role in keeping clothing in circulation, yet both fieldwork and interviews revealed a number of pressures that limit how effectively they can do so.

What becomes visible is a mismatch between what the city hopes the textile system can achieve, a circular flow where textiles are reused for as long as possible, and what the system is currently able to support, a system with limited reusability of textiles due to several challenges. Items often arrive in poor condition, sorting processes rely heavily on manual labour, and NGOs must absorb the financial burden of waste disposal. These issues are shaped not only by operational realities but also by material qualities (such as the rise of low-durability fast fashion), uneven access to donation points, and regulatory frameworks that are still adjusting to EU-level requirements for textile collection.

The broader problem, therefore, is not tied to a single actor or bottleneck. Instead, it reflects how everyday behaviours, organisational capacities, material infrastructures, and regulatory pressures interact in ways that cause textiles to drop out of circularity sooner than they should. Our project engages with this challenge by trying to understand where these misalignments happen and what kinds of interventions, organisational, behavioural, or infrastructural, could help Tallinn move closer to its circularity goals.

3.5 Research Questions

1. Where do textiles drop out of Tallinn's circular reuse system?
2. What organizational challenges do reuse centers face?
3. What barriers prevent donors from engaging in the textile reuse ecosystem?
4. How can infrastructure intervention improve donation accessibility?

3.6 Report Organization

This report is organized into the following sections. Section 1 presents our executive summary. Section 2 presents the team task distribution. Section 3 provides the introduction; background, problem statement, objectives, problem context and analysis, questions, and

report organization. Section 4 details our methodology which includes Actor-Network Theory, Value Sensitive Design, contextual inquiry approach, and data collection. Section 5 describes the data analysis, results and presents our prototype solution. Section 6 presents our reflections on our process and findings and conclusions. References and appendices are detailed in sections 7 and 8 respectively

4.0 Methodology

Our methodology employs the Actor-Network Theory, Value Sensitive Design, and contextual inquiry approaches to holistically examine Tallinn's textile eco system from production to consumption to reuse and recycling. These methods aided in understanding what role each actor plays in the ecosystems, what values they hold, how these values and the inability to meet them create bottlenecks that hinder full circularity of the ecosystem.

4.1 Actors and Actor-Network Theory

To understand the textile challenge in Tallinn, we began by building an Actor-Network-Theory (ANT) (Law, 1992)[6] map that captured the different stakeholders involved in the flow of textiles and the relationships that connect them. ANT was chosen as a core method because it allows us to examine socio-technical systems without assuming that certain actors are inherently more important than others. Instead, it encourages us to see how human actors, such as consumers or NGO staff, and non-human actors, such as donation bins, sorting bags, or policy regulations, jointly shape how textiles travel through the system.

We used ANT early in the project to organise a system that initially felt overwhelmingly complex. The textile lifecycle in Estonia spans global production chains, local manufacturers, retailers, consumers, reuse organisations, and policymakers. ANT allowed us to lay these elements out as a connected network rather than a linear supply chain, making it easier to see how decisions, behaviours and infrastructures in one part of the system influence outcomes elsewhere.

Our final actor network reflects this complexity. On the production side, actors such as the Port of Tallinn, fabric wholesalers, and local manufacturers like LENNE, Baltika/Ivo Nikkolo, and Protex Balti form the upstream pathways through which textiles enter Estonia. These actors link directly into the distribution system, represented by shopping centres and e-commerce platforms such as Zalando, Shein, and Vinted. Consumers, including residents, students and institutional buyers, sit at the centre of the network, because their behaviour determines whether textiles move toward reuse, repair or waste.

ANT helped us recognise consumers as a critical junction where textiles can either remain in circulation or drop out of it. Fieldwork confirmed this: both Humana and Uuskasutuskeskus reported that the quality, cleanliness and handling of donated textiles vary widely, and this variation strongly affects sorting outcomes. Consumers therefore act not just as end users but as decision-makers who influence the flow of materials downstream.

[6] Law, J. Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. Systems Practice 5, 379–393 (1992). https://doi.org/10.1007/BF01059830

The reuse and repair section of our network includes Humana Eesti, Uuskasutuskeskus, and upcycling actors. These organisations form the heart of Tallinn's circular economy efforts, yet they also represent one of the major bottlenecks in the system. As shown in our ANT map, approximately 60–70% of donations are not immediately resold. ANT allowed us to highlight this bottleneck visually and conceptually, showing how materials, labour, and organisational routines converge to shape the fate of donated textiles.

The policy layer, consisting of the City of Tallinn's Environment Department, the Ministry of Climate/Environment, and EU frameworks, acts as an overarching structure influencing every stage of the network. These non-human actors (in ANT terms) stabilize certain practices, such as how textiles must be collected or how waste must be categorised, while also constraining experimentation by NGOs who must operate within legal and financial boundaries.

Developing the ANT map was therefore not only a descriptive exercise but also a diagnostic one. It helped us identify where relationships between actors were weak, misaligned, or overloaded. Most importantly, it showed exactly where textiles are most likely to become waste: at the intersection between consumer donation behaviour, sorting capacity, and material quality. This insight shaped the next stages of our project, guiding our contextual inquiry and helping us focus on interventions that target this critical junction in the network. Developing the ANT map helped us move beyond description and begin identifying where the system shows weak or uneven connections. This insight shaped the following stages of our project by directing our attention toward interventions in this critical part of the network.

4.2 Value Sensitive Design Analysis

Purpose and Scope

This section applies Value Sensitive Design (VSD) (Friedman et al, 2017)[7] to the AISS SPICE textile reuse challenge, grounding some of our proposed solutions in explicitly articulated human and societal values. Drawing on the VSD framework presented in the course lecture slides, this analysis translates abstract values into concrete norms and design requirements for two proposed interventions:

1. Strategic placement of textile donation bins in student environments.
2. Adoption of reusable storage and transport bags (e.g., Ghana Must-Go bags) within reuse organisations.

The aim is to demonstrate how these interventions do not merely improve efficiency, but actively embody and promote values that are central to the circular economy, social justice, and sustainable socio-technical systems.

[7] Friedman, B., Hendry, D. G., & Borning, A. (2017). *Value Sensitive Design: Shaping Technology with Moral Imagination*. MIT Press. Retrieved November 18, 2025 from https://mitpress.mit.edu/9780262039536/value-sensitive-design/

VSD Perspective: Technologies as Value-Laden

Following the interactionist view outlined in the lecture slides, this project treats textile infrastructure (donation bins, storage bags, sorting systems) as neither neutral tools nor fully deterministic forces. Instead, values are sometimes embedded in the interaction between users, organisations, and material artefacts. Other times, the existence of the material itself also holds value with or without any form of interaction with it.

For example:

- The location of a donation bin shapes who is able to donate, how often, and with what effort.
- The choice of storage materials influences labour conditions, environmental impact, and long-term operational costs.

Design decisions therefore implicitly prioritise certain values over others. Making these priorities explicit is a core objective of VSD.

Stakeholders and Value Considerations

Based on the Actor-Network-Theory (ANT) (Law, 1992)[8] analysis, the following key stakeholder groups are relevant for the VSD (Friedman et al, 2017)[9] analysis:

- **Primary stakeholders**: students, employed residents, donors, sorting staff, volunteers.
- **Secondary stakeholders**: reuse organisations (Uuskasutuskeskus, Humana), logistics workers, partner organisations.
- **Indirect stakeholders**: municipalities, policymakers, future generations, and the environment.

Values were identified through field visits, interviews, survey data, and policy context rather than assumed a priori.

Key Values Identified

Across the empirical material and policy context, the following values emerged as most salient:

- **Sustainability**: reducing textile waste, extending product lifecycles, minimising environmental harm.
- **Accessibility and Inclusiveness**: enabling diverse groups (especially students and time-constrained workers) to participate in reuse systems.

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[8] Law, J. Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. Systems Practice 5, 379–393 (1992). https://doi.org/10.1007/BF01059830

[9] Friedman, B., Hendry, D. G., & Borning, A. (2017). *Value Sensitive Design: Shaping Technology with Moral Imagination*. MIT Press. Retrieved November 18, 2025 from https://mitpress.mit.edu/9780262039536/value-sensitive-design/

- **Fairness and Justice**: avoiding disproportionate burdens on NGOs, volunteers, and low-capacity organisations.
- **Care and Responsibility**: encouraging respectful donation practices and stewardship of donated goods.
- **Well-being and Dignity of Labour**: improving working conditions for sorters and logistics staff.
- **Efficiency and Reliability**: ensuring systems function at scale without creating new bottlenecks.

These values sometimes align but can also come into tension, requiring explicit prioritisation and trade-offs.

4.3 Contextual inquiry

4.3.1 Data Collection Methods

We conducted contextual inquiry (Raven & Flanders, 1996)[10] through semi-structured interviews(Bariball & While, 1994)[11] and surveys to understand textile industry operations and consumer behaviour in Tallinn and Estonia as a whole. We interviewed managers from Uuskasutuskeskus and Humana, exploring operational motivations, barriers, and potential solutions to these barriers (see appendix A for full interview questions). Semi-structured interviews enabled us to probe deeply into unexpected responses through spontaneous follow-up questions while observing non-verbal cues that enriched our understanding of their perspectives. This interview approach provided the nuanced qualitative data necessary to understand the complexities of how these companies operate within the circular textile economy and the values driving their word.

Simultaneously, we distributed Google Form surveys to textile consumers across Tallinn to understand their purchasing considerations, shopping locations, purchase frequency, and recycling and donation habits (see appendix B for full survey questions). The survey method enabled cost-effective data collection from a broader audience than interviews would allow given our limited time and financial constraints, while Google Forms automatically organized responses for seamless analysis. This mixed-method approach combined the depth of qualitative insights from interviews with the breadth of quantitative patterns from surveys, providing comprehensive data on both supply-side operations and demand-side consumer behaviours within Estonia's textile ecosystem.

[10] Raven & Flanders (1996). Using contextual inquiry to learn about your audiences. https://dl.acm.org/doi/epdf/10.1145/227614.227615

[11] Bariball & While (1994). Collecting data using a semi-structured interview: a discussion paper. https://www.academia.edu/download/34291860/Barriball___While_1994_Collecting_data_using_a_semistructured_interview_JAN.pdf

4.4 Project Constraints

The challenge operates within several important constraints that shaped both the client's expectations and the boundaries of what our project could propose. These constraints come from regulations, existing infrastructures, organisational routines, and public behaviour factors that are not easily changed but must be acknowledged when thinking about solutions.

A major constraint is the regulatory environment. Estonia must soon comply with the EU Waste Framework Directive[12] by implementing textile-specific Extended Producer Responsibility. These frameworks set clear obligations for how textiles must be collected and managed, but they also limit the freedom of NGOs and municipalities to adopt new practices on their own terms. Current taxation rules, such as VAT on second-hand goods[13] sales and commercial waste fees for NGOs, add additional financial pressure and restrict what reuse organisations can afford to experiment with[14].

A second constraint relates to organisational capacity and infrastructure. Reuse centres depend heavily on manual sorting, and their storage areas, donation bins, and workflows are fixed within existing budgets. Staff availability is limited, and even when donation volumes increase, organisations cannot easily scale their operations. These factors create bottlenecks that no single technological or behavioural intervention can quickly resolve.

Material and behavioural constraints also play a significant role. A growing share of donated clothing consists of synthetic, low-durability fast fashion that is difficult to resell or repurpose. In addition, some donations arrive dirty or damaged, which immediately removes them from the reuse cycle and requires NGOs to pay disposal fees. Public habits and awareness shape these patterns, and because such behaviours are slow to change, they form a structural limitation.

Finally, the spatial distribution of donation points affects who donates and how often. With many collection points located in central areas, residents in other districts face more friction when trying to donate, which may contribute to textiles being discarded as household waste instead.

Taken together, these constraints show that the textile challenge is embedded in a complex environment where rules, infrastructures, behaviours, and material qualities all shape what is possible. Any intervention must work with, not against, these realities.

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[12] European Commission. (2025). Waste Framework Directive. Retrieved November 10, 2025, from https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

[13] Estonian Tax and Customs Board. (n.d.). Special arrangements for imposing value added tax on sale of second-hand goods. Value Added Tax Act § 42. Retrieved November 10, 2025 from https://www.riigiteataja.ee/en/eli/527022014003/consolide

[14] Interview data from Uuskasutuskeskus and Humana managers - see link attached in Appendix A

5.0 Data Analysis and Results

5. 1 Actor Network Theory

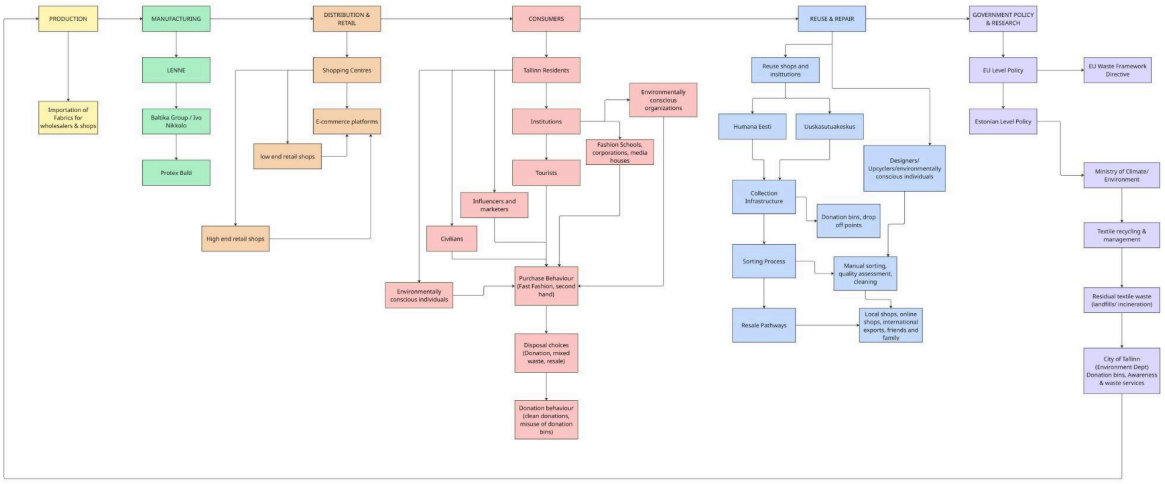

Figure I: created by authors

This is our final updated ANT representing the textile ecosystem within Estonia.

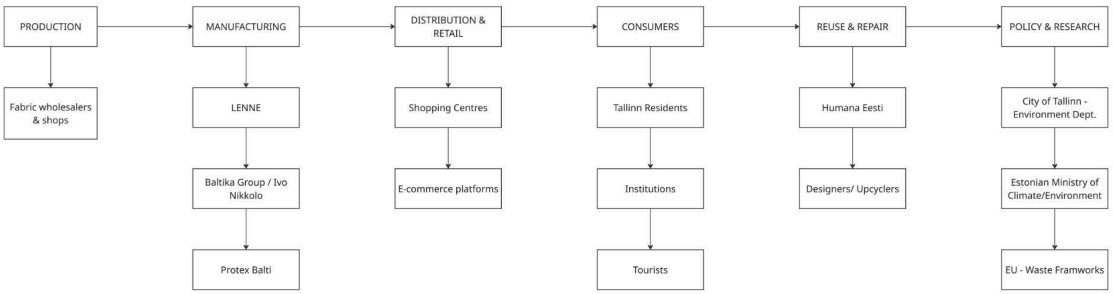

Figure II: created by authors
This was our first ANT which has been updated.
Note: the images above are not clear so we have attached a link here to access a higher quality resolution of the ANTs.

5.2 Value Sensitive Design

Explicit Value–Norm–Design Mapping (Value Hierarchy)

This section makes the Value Sensitive Design logic explicit by directly connecting values → norms → design requirements → concrete solution features. This responds to the core VSD requirement that values must be materially instantiated in design rather than remaining abstract.

1.0 Value Hierarchy for Solution 1: Donation Bins in Student Environments (Table)

Values	Norms (What should hold true)	Design Requirements	Concrete Design Features (Solution 1)
Sustainability	Reusable textiles should not enter mixed waste due to inconvenience	Donation must be low-effort and routine	Donation bins located directly on/near campus and student dormitories
Accessibility	Participation in reuse should not depend on time, car ownership, or income	Donation points must align with daily mobility patterns	Bin placement along student walking routes (campus–dorm–public transport)
Inclusiveness	Students and young people should be able to participate equally in circular systems	Infrastructure should target under-served donor groups	Dedicated student-area bins rather than only city-centre locations
Care & Responsibility	Donors should understand what counts as a suitable donation	Donation guidance must be visible at the point of action	Clear, simple signage on bins explaining acceptable conditions
Fairness to NGOs	NGOs should not bear excess sorting and disposal costs	Donation quality should be improved upstream	Visual cues and instructions to reduce dirty or damaged donations

Note on NGO disposal costs: The EU Waste Framework Directive, when fully implemented in Estonia, is expected to shift textile waste disposal costs away from NGOs through Extended Producer Responsibility (EPR) schemes. However, as of 2025, this framework is not yet operational, meaning NGOs currently bear these costs directly. As Merja noted in review feedback, NGO waste costs could theoretically serve as an incentive for these organizations to advocate for upstream consumption reduction and improved waste management policies. However, in practice, these costs currently create operational strain without providing sufficient leverage for systemic change. The fairness question becomes more complex when viewed systemically: the ideal solution likely involves both implementing EPR frameworks (removing unfair cost burdens) and creating separate incentives for waste reduction advocacy, rather than relying on financial pressure alone.

1.1 Value embodiment:

This solution embeds sustainability and inclusiveness through infrastructural convenience rather than behavioural pressure. Responsibility is operationalised through information

design, while fairness is addressed by reducing avoidable waste handling for reuse organisations.

1.2 Core Values

- Sustainability
- Accessibility
- Inclusiveness
- Responsibility

1.3 Norms

- Donating textiles should require minimal extra effort.
- Reuse systems should accommodate the daily routines of students and workers.
- Donation infrastructure should reduce the likelihood of textiles entering mixed waste streams.

1.4 Design Requirements

- Donation bins placed directly on or adjacent to university campuses and student dormitories.
- Clear visual and textual guidance on acceptable donation conditions to reduce contamination.
- Bin design that signals care and legitimacy (clean, well-maintained, clearly branded).

1.5 Projected Outcome of Value Embodiment

By reducing spatial and temporal friction, the design operationalises accessibility and inclusiveness. At the same time, clearer guidance reinforces responsibility and care, aligning donor behaviour with the capacities of reuse organisations. The system thus supports sustainability not through moral pressure, but through infrastructural convenience.

2.0 Value Hierarchy for Solution 2: Reusable Storage and Transport Bags (Table)

Values	**Norms (What should hold true)**	**Design Requirements**	**Concrete Design Features (Solution 2)**
Sustainability	Internal reuse operations should minimise single-use plastics	Storage systems must be reusable and long-lasting	Replacement of single-use plastic sacks with reusable Ghana Must-Go bags

Well-being of Labour	Sorting and logistics work should not be physically harmful or inefficient	Bags must be durable, ergonomic, and easy to handle	Strong woven bags with flexible form and reinforced seams
Fairness	NGOs should not absorb hidden environmental or labour costs	Long-term cost per use must be lower than disposables	High reuse-cycle bags that reduce replacement frequency
Efficiency	Sorting and transport should not be slowed by material failure	Storage containers must withstand repeated handling	Reduced tearing, fewer re-bagging incidents during sorting
Responsibility	Circular organisations should model sustainable internal practices	Operational tools should reflect organisational values	Visible shift away from disposable materials in daily operations

2.1 Value embodiment

This solution embeds sustainability and labour dignity directly into organisational routines. Unlike awareness campaigns, the value commitment is enacted materially every day through the tools workers use, reinforcing both environmental responsibility and operational efficiency.

2.2 Core Values

- Sustainability
- Fairness
- Well-being of workers
- Efficiency

2.3 Norms

- Internal reuse operations should minimize single-use materials.
- Storage and transport systems should be durable and safe for repeated handling.
- Environmental improvements should not increase operational strain on workers.

2.4 Design Requirements

- Use of durable, reusable bags capable of withstanding multiple sorting and transport cycles.

- Bags that are ergonomically manageable and easy to stack, open, and close.
- Cost per use is lower than or comparable to single-use plastic bags over time.

2.5 Projected Outcome of Value Embodiment

Replacing disposable plastic bags with reusable alternatives embeds sustainability directly into daily organisational practice. At the same time, improved durability and handling conditions support worker well-being and operational fairness by reducing breakage, re-bagging, and unnecessary labour.

3.0 Value Tensions and Trade-offs

Several value tensions identified in the lecture material are also present in this project:

- **Convenience vs. Donation Quality**: Increasing accessibility may initially increase low-quality donations. This is mitigated through clearer guidance rather than restricting access.
- **Sustainability vs. Cost**: Reusable bags require higher upfront investment. This is addressed through lifecycle cost reasoning and potential grant funding.
- **Efficiency vs. Inclusiveness**: Fast sorting favours standardisation, while inclusiveness introduces heterogeneity in donations. The proposed solutions aim to balance both by intervening at different system points.

Recognising these tensions aligns the project with Friedman et al.'s (2017) grand challenge of managing value conflicts rather than assuming value alignment.

4.0 Implementation Perspective

Both solutions combine bottom-up and top-down elements:

- Bottom-up: responding directly to observed practices, user behaviour, and organisational needs.
- Top-down: aligning with EU textile collection mandates and municipal sustainability goals.

The ultimate goal is not merely compliance or efficiency, but the reinforcement of a textile reuse system that is ethically robust, socially inclusive, and environmentally more responsible than current practices.

5.0 Conclusion

Applying Value Sensitive Design (Friedman et al, 2017)[15] to the AISS SPICE textile challenge makes explicit how seemingly modest infrastructural decisions embody significant

[15] Friedman, B., Hendry, D. G., & Borning, A. (2017). *Value Sensitive Design: Shaping Technology with Moral Imagination*. MIT Press. Retrieved November 18, 2025 from https://mitpress.mit.edu/9780262039536/value-sensitive-design/

values. By translating sustainability, fairness, and accessibility into concrete design requirements, the proposed interventions demonstrate how socio-technical systems can be deliberately shaped to support circularity without placing unrealistic moral or operational burdens on any single actor.

This VSD analysis complements the ANT-based system mapping and empirical findings, strengthening the normative foundation of the project and clarifying why the proposed solutions matter beyond technical performance alone.

5.3 Contextual Inquiry

Interview data from our site visit to Uuskasutuskeskus and Humana virtual meeting was analyzed through thematic analysis (Ahmed et al., 2025)[16] focusing on operational challenges, donation quality, and system bottlenecks. Survey data was analyzed using descriptive statistics (Riina et al., 2023)[17] to identify patterns in donation behavior across demographics.

5.3.1 Textile flow and system bottlenecks

Uuskasutuskeskus has 4 collection centers in Tallinn with labor-intensive sorting (50-60 bags per day per worker). Uuskasutuskeskus also cites 5% waste of all donated items, only 30-40% of donated items resellable with the remainder redirected to partner organizations or exported internationally. Humana on the other hand processes 30-35 tons of textiles per day with 30 sorting categories. Both organizations report 60-70% of donations are immediately resold, indicating a systemic bottleneck in matching donated items to local demand. Survey responses show that 88% of employed residents donate but cite distance and time barriers.

5.3.2 Donation quality challenges

Both organizations identify unsuitable or damaged items in donations received which increase disposal costs. Humana cites fast fashion from Shein/TEMU as being regular in recent donations received which increases the amount of donated items that end up as textile waste. While Uuskasutuskeskus explains some donors treat donation boxes as a garbage disposal alternative, reducing the quality of donations received. Survey results also demonstrate 30% of respondents are uncertain about acceptable donation standards

[16] Ahmed, S. K., Mohammed, R. A., Nashwan, A. J., Ibrahim, R. H., Abdalla, A. Q., Ameen, B. M. M., & Khdhir, R. M. (2025). Using thematic analysis in qualitative research. Journal of Medicine, Surgery, and Public Health, 6, 100198. https://doi.org/10.1016/j.glmedi.2025.100198

[17] Riina, M. D., Stambaugh, C., Stambaugh, N., & Huber, K. E. (2023). *An overview of the fundamentals of data management, analysis, and interpretation in quantitative research*. *Seminars in Oncology Nursing, 39*, 151398. https://doi.org/10.1016/j.soncn.2023.151398

5.3.3 Infrastructure and accessibility issues

Survey reveals students have to walk considerable distances to access donation points which impacts their ability to donate regularly. 30% of survey respondents cite inconvenient donation points as a significant barrier to their ability to donate. Survey results show 71% of employed respondents are limited by time to access donation points, not motivation. Both organizations acknowledge that there are insufficient convenient donation points.

5.3.4 Operational and Regulatory Constraints

Both organizations are currently subject to waste disposal fees which increase their operational costs. Uuskasutuskeskus, because of operational costs, cannot lower prices lower than commercial businesses. Uuskasutuskeskus also experiences storage limitations as single-use plastic bags tear and are unsustainable.

5.4 Prototype Design

This section presents the low-fidelity prototypes developed in response to key insights identified through surveys, interviews, and system-level analysis. While student respondents demonstrated high environmental motivation, findings revealed that lower purchasing power, smaller donation volumes, and limited access to convenient donation options reduce actual donation frequency. These results suggest that, for students, infrastructure proximity and practical support mechanisms are more influential than awareness alone.

Across the research phases, several recurring barriers to textile donation and recycling were identified. Respondents frequently cited distance to donation points, uncertainty about acceptable clothing conditions, lack of time, and not knowing where or how to donate as factors discouraging participation. Together, these barriers highlight a gap between positive environmental attitudes and actionable behavior.

The prototypes presented in this section address these barriers at different stages of the donation lifecycle. Rather than focusing solely on motivation, they prioritize reducing friction, increasing clarity, and improving system efficiency. The three solutions, improving donation quality (pre-donation), enhancing access to donation bins (donation), and introducing better storage solutions (post-donation) were developed iteratively and evaluated as complementary interventions within the textile reuse ecosystem.

5.4.1 Solution 1: Improving Donation Quality

This prototype addresses a problem related not to access or logistics, but to the quality of donated clothing. This issue was identified through expert input during our visit to *Uuskasutuskeskus* and further supported by findings from our survey.

During the interview, a representative from Uuskasutuskeskus explained that a significant portion of donated clothing arrives in extremely poor condition, including items that are heavily damaged, stained, or unsuitable for reuse. These items cannot be sold or redistributed and must instead be discarded. Importantly, the organization bears the financial cost of disposing of these textiles, meaning that low-quality donations create both environmental and economic burdens for reuse organizations.

Survey results helped contextualize this issue from the donor's perspective. While respondents generally expressed positive attitudes toward donating clothes, many indicated uncertainty about what conditions are acceptable for donation. This revealed a misalignment between donor intentions and organizational needs: people want to donate responsibly, but lack clear guidance on minimum quality standards.

This insight prompted a reframing of the problem from one of donor motivation to one of information and awareness. Rather than discouraging donations, the challenge became how to help donors make better-informed decisions before donating.

The resulting prototype focused on communication-based interventions aimed at improving donation quality at the source. Through brainstorming and ideation, we explored low-cost, scalable methods to convey clear guidelines about acceptable donation conditions. Two complementary approaches were identified as conceptual prototypes:

1. Informational posters placed near donation bins and in student environments, and

2. Influencer-led awareness campaigns, particularly on social media platforms frequently used by students.

Posters were envisioned as low-fidelity visual prototypes, using simple language and icons to communicate "donate" versus "do not donate" examples (e.g., clean and intact clothing versus heavily damaged or unusable items). This approach leverages the moment of decision-making, providing guidance precisely when users are about to donate.

Influencer-based communication was explored as a parallel prototype targeting earlier stages of the donation journey. By collaborating with student influencers or sustainability-focused content creators, donation quality guidelines could be disseminated in a relatable and non-institutional manner. This approach recognizes influencers as key actors within the network who can shape norms and behaviors at scale.

Both prototypes were evaluated through scenario-based reasoning (Rosson et al, 2002)[18] and system-level analysis (SEBoK, 2025)[19], considering how clearer information could reduce waste handling costs, improve sorting efficiency, and strengthen trust between donors and reuse organizations. From an Actor-Network Theory (ANT) perspective, these interventions act as mediators that reshape interactions between donors, donation infrastructure, and organizations by aligning expectations across the network.

This prototype complements the previous two solutions by addressing the pre-donation stage of the textile reuse process. While improved bin placement increases participation and better storage enhances operational sustainability, improving donation quality ensures that increased volume does not result in increased waste. Together, the three prototypes form a coherent, multi-stage intervention aimed at strengthening the overall effectiveness of Tallinn's textile reuse system.

5.4.2 Solution 2: Storage Bins

This solution developed through our iterative prototyping process focuses on improving students' access to textile donation infrastructure. Although survey results indicate that

[18] Rosson, M. B., & Carroll, J. M. (2002). Scenario-based design. In J. A. Jacko & A. Sears (Eds.), The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications (pp. 1032-1050). Lawrence Erlbaum Associates.

[19] SEBoK. (2025). System Analysis. Retrieved November 18, 2025 from https://sebokwiki.org/wiki/System_Analysis

students demonstrate high environmental motivation, their lower purchasing power, smaller clothing volumes, and limited access to nearby donation options reduce donation frequency. This suggests that, for this group, the proximity and convenience of infrastructure are more influential than additional awareness campaigns. This design direction emerged from the combined use of spatial analysis, survey data, and system-level reflection.

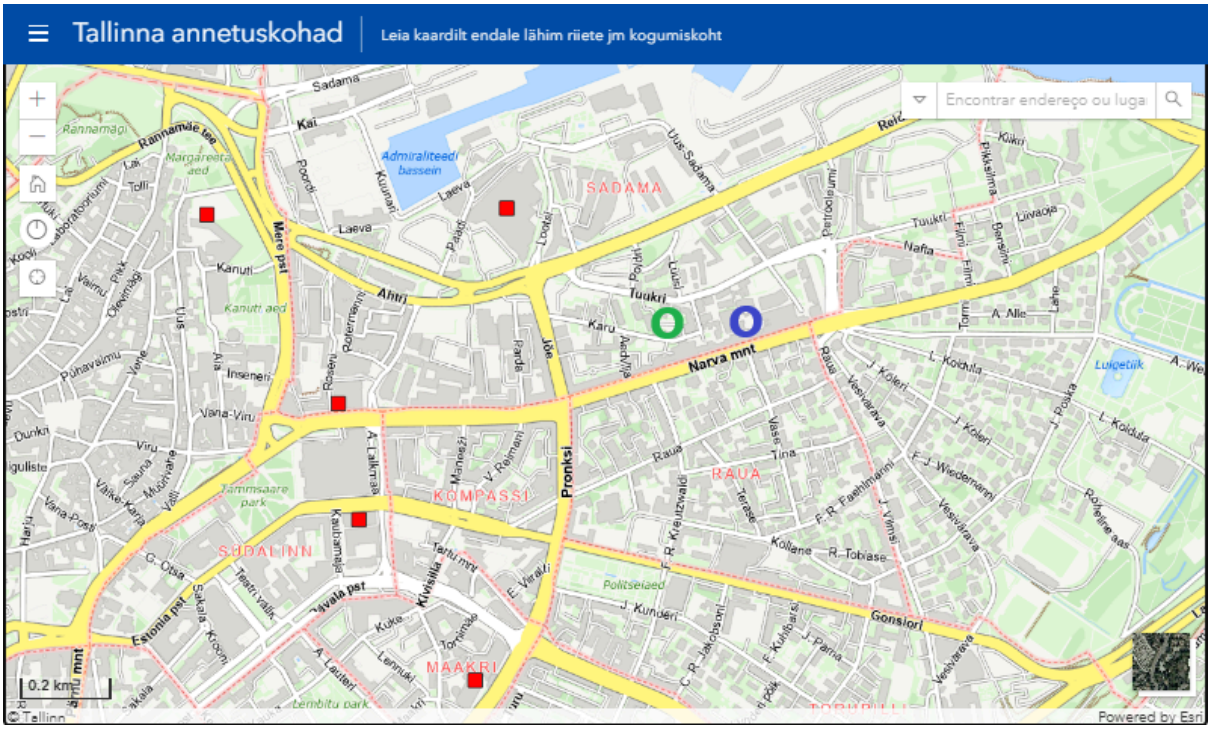

Figure III: Clothes donation bins near TLU. Source: https://www.tallinn.ee/en/keskkond/korduskasutus

As an initial step, we used map-based visual analysis to examine the spatial relationship between existing clothing recycling bins and key student locations. Using publicly available data from the City of Tallinn, we mapped current donation bin locations (represented in red) in relation to Tallinn University (represented in blue) and the nearby student dormitory at Karu 17 (represented in green). This visual mapping functioned as an early low-fidelity prototype, allowing us to concretely assess accessibility rather than relying on assumptions.

The analysis showed that the closest donation bin is approximately an 11-minute walk (800 meters) from the Karu 17 dormitory and a 14-minute walk (1 kilometer) from Tallinn University. While these distances are relatively short, they are not convenient in everyday practice. Prior research and behavioral insights suggest that donating clothing is perceived as a voluntary and generous act; therefore, even small inconveniences can significantly reduce participation. This spatial insight revealed a clear gap between availability and actual usability of donation infrastructure.

Meanwhile in Taltech, there is a donation bin inside the University campus, making the donation process easier and more convenient for students, professors and workers.

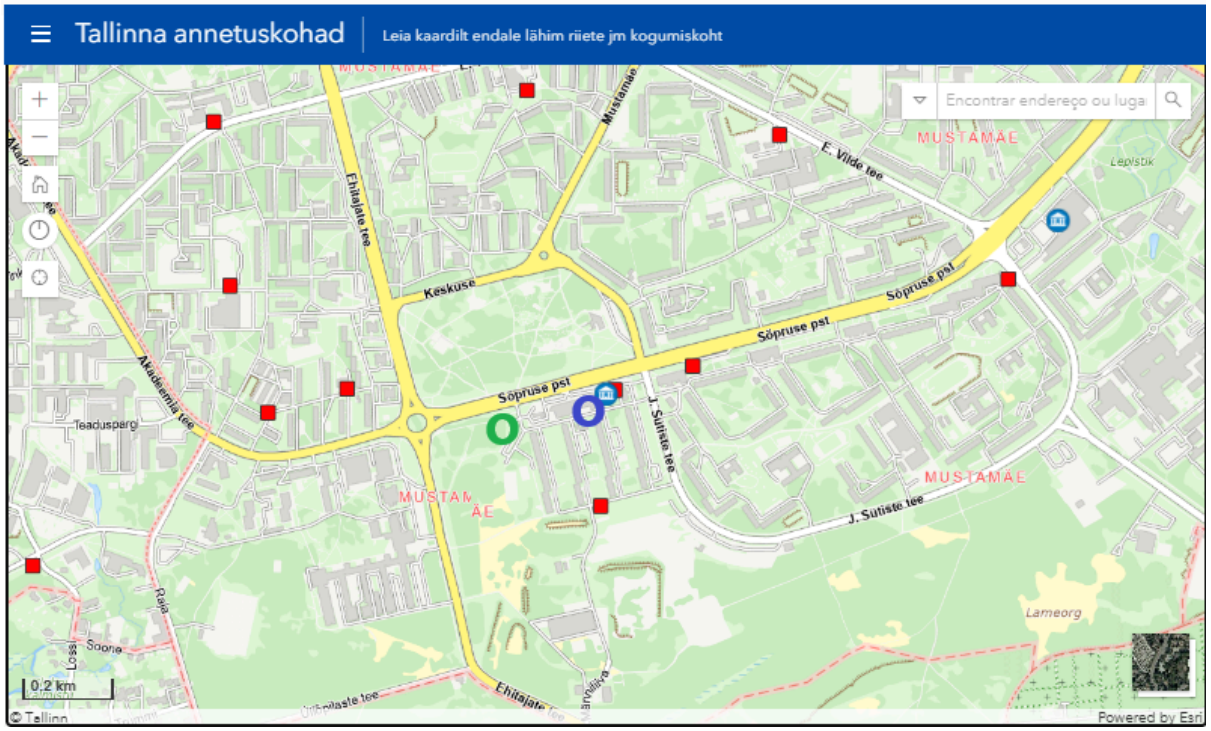

Figure IV: Clothes donation bins near Taltech Source: https://www.tallinn.ee/en/keskkond/korduskasutus

The second iteration of this prototype was informed by findings from our survey. Survey responses indicated that students are both major consumers of fast fashion and generally willing to donate unused clothing, provided that the process is easy and accessible. This positioned students as a key but currently underserved user group within Tallinn's textile donation system. The convergence of spatial data and survey insights strengthened our confidence in targeting student environments as strategic intervention points.

Based on these findings, we iteratively refined the prototype toward the idea of placing donation bins directly at or near student dormitories and university campuses, specifically at Tallinn University or the Karu 17 dormitory. This conceptual prototype does not represent a final infrastructural plan but rather a service-level intervention, visualized through location mapping and scenario-based reasoning (e.g., a student donating clothes while commuting to class or returning from travel).

Throughout this process, low-fidelity prototyping methods were intentionally used. Mapping tools, annotated visuals, and scenario walkthroughs allowed us to test assumptions quickly and collaboratively without introducing unnecessary technical complexity. The Actor-Network Theory (ANT) framework further supported this iteration by highlighting

how small changes in bin placement could positively influence multiple actors in the system, including donors, logistics teams, and reuse organizations.

This iterative design process demonstrates how combining spatial tools, user research, and system thinking can guide the refinement of realistic and context-sensitive interventions. The resulting prototype aligns donor behavior with infrastructural convenience, increasing the likelihood that textiles remain within circular reuse pathways rather than entering mixed waste streams.

Alternatively, pick up services for donations can also be a solution for people living further away from main collection points. Trucks and mobile bins can be used to include these people on the textile donation chain.

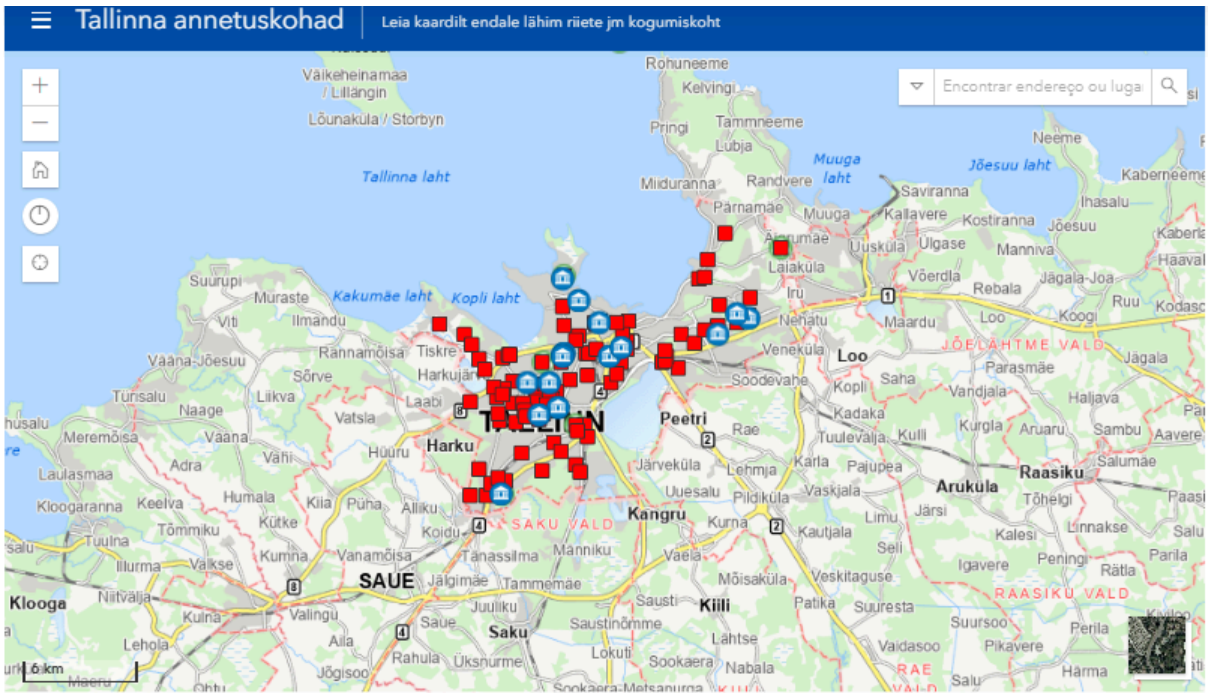

Figure V: Clothes donation bins in Tallinn. Source: https://www.tallinn.ee/en/keskkond/korduskasutus

5.4.3 Solution 3: Better Storage Solutions

This solution emerged later in the research process and was not identified during the initial desk research or survey phase. Instead, it was discovered through field observation and expert interview during our visit to *Uuskasutuskeskus*, highlighting the importance of real-world engagement in iterative design.

During a conversation with a representative of Uuskasutuskeskus, we learned that donated clothes are currently stored and transported using large plastic waste bags with zip closures. While this method is widely used due to its low cost and practicality, it presents clear sustainability drawbacks. The bags are made of plastic, are prone to tearing after repeated

use, and contribute to long-term environmental waste. The organization is aware of these limitations but continues to use this solution due to financial constraints, as more eco-friendly alternatives (such as reusable potato sacks) and more practical solutions (such as plastic storage crates/boxes) are significantly more expensive.

This insight prompted a reframing of the problem, shifting our focus from donation accessibility alone to the post-donation lifecycle of textiles. At this stage, our prototype evolved from a user-facing intervention into a system-level one, addressing logistical and operational challenges faced by reuse organizations.

Following the interview, we conducted a brainstorming session to explore alternative storage and transportation solutions that would be affordable, reusable, and environmentally preferable. Through this ideation process, we identified *Ghana Must-Go bags* as a promising conceptual prototype. These bags are widely used, durable, flexible, and designed to carry large volumes of textiles, making them suitable for repeated handling and transport.

Figure VI: Ghana Must-Go bags. Source: https://www.bbc.com/news/world-africa-67581683

As a low-fidelity prototype, the Ghana Must-Go bag - durable woven polypropylene bags, named after their historical use during the 1983 Ghanaian exodus from Nigeria - was evaluated primarily through scenario-based testing and comparative reasoning, rather than physical deployment. We examined how such bags could replace single-use plastic sacks in storage areas, sorting facilities, and transportation workflows. Compared to plastic waste bags, this solution offers increased durability, reduced plastic waste, and improved handling efficiency, while remaining relatively low-cost.

This iteration demonstrates how expert input and contextual inquiry can uncover hidden inefficiencies that are not visible through surveys alone. By integrating insights from

practitioners into the design process, the prototype expanded beyond individual donor behavior and addressed sustainability challenges embedded within organizational practices. As such, this solution complements the donation bin prototype by strengthening the circular system at a later stage of the textile reuse process.

5.5 Prototype Iterative Testing and Evaluation

This section outlines the proposed and envisioned methods for testing and evaluating the three low-fidelity prototypes developed in this project. Due to time, resource, and scope limitations, the prototypes were not physically deployed or empirically tested. Instead, this section describes how each prototype *would* be evaluated in a subsequent iteration to validate assumptions before implementation.

The proposed evaluation strategies are grounded in early-stage design research principles, focusing on assumption validation, feasibility, and system alignment rather than performance optimization or long-term impact measurement. Each prototype is considered within its respective stage of the donation lifecycle: pre-donation, donation, and post-donation.

5.5.1 Envisioned Evaluation of Prototype 1: Improving Donation Quality (Pre-Donation Stage)

The first prototype addresses the quality of donated clothing through communication-based interventions such as posters near donation points and influencer-led awareness campaigns. Since this prototype focuses on donor understanding and decision-making, its evaluation would primarily assess clarity, comprehension, and perceived usefulness.

In a future iteration, testing could be conducted through scenario-based evaluations, where participants are presented with hypothetical donation situations (e.g., selecting clothes to donate before visiting a bin). Participants would be asked to reflect on whether exposure to clear visual or digital guidelines would increase their confidence in deciding what items are suitable for donation.

To complement this qualitative approach, short questionnaires could be used to capture changes in perceived knowledge and confidence after exposure to the prototype materials. These tools would help assess whether the intervention reduces uncertainty without discouraging donations.

From an organizational perspective, evaluation would also consider anticipated system-level effects, such as reduced sorting time and lower disposal costs. Using an Actor-Network Theory (ANT) lens, informational materials and influencers would be analyzed as mediating actors capable of reshaping interactions between donors and reuse organizations by aligning expectations before donation occurs.

5.5.2 Envisioned Evaluation of Prototype 2: Storage Bins (Donation Stage)

The second prototype proposes the strategic placement of textile donation bins in student-dense environments in order to improve accessibility and increase participation. As a service-level intervention, its evaluation would primarily focus on perceived convenience, behavioral intention, and relative effectiveness when compared to existing infrastructure.

In a future testing phase, scenario-based walkthroughs could be conducted to simulate everyday student routines, such as commuting to university buildings or returning to student dormitories. Participants would be asked to reflect on how the presence of a donation bin within or near these spaces might influence their likelihood of donating clothes, compared to current practices that require additional travel or effort.

Beyond perceptual evaluation, a comparative, data-informed approach could also be adopted. A relevant reference point already exists at TalTech, where a donation bin is located inside the university campus. An envisioned evaluation method would involve analyzing the volume and frequency of textile donations collected at the TalTech bin over a defined period, and using this data as a benchmark. These figures could then be compared to donation volumes from bins located further away from student environments, such as those near Tallinn University or Karu 17, should a pilot bin be introduced there.

This comparative analysis would help assess whether proximity to student daily routes has a measurable impact on donation behavior, supporting or challenging the assumption that infrastructure accessibility is a stronger driver than awareness alone.

In parallel, short feedback questionnaires could be used to capture students' perceived convenience, sense of effort, and motivation to donate when bins are located on campus versus off-site. While subjective, this data would complement quantitative comparisons and provide early indicators of user acceptance.

Finally, a feasibility assessment would be necessary to evaluate organizational readiness and operational constraints. This assessment would consider factors such as bin security, collection frequency, maintenance responsibilities, and coordination with textile reuse organizations. The combined insights from behavioral, comparative, and logistical evaluations would inform whether the prototype should be refined, scaled to other student locations, or adapted into alternative formats, such as shared or temporary donation points.

5.5.3 Envisioned Evaluation of Prototype 3: Better Storage Solutions (Post-Donation Stage)

The third prototype focuses on replacing single-use plastic waste bags with reusable storage solutions, such as Ghana Must-Go bags. As a system-level intervention, its evaluation would emphasize durability, usability, and environmental performance.

In a future iteration, evaluation could be conducted through a small-scale comparative trial, where the proposed reusable bags are used alongside existing plastic bags during regular storage and transportation activities. Performance indicators such as number of reuse cycles, handling efficiency, and incidence of damage would be documented.

To complement quantitative observations, semi-structured interviews with operators (e.g., sorters and drivers) would be conducted to capture qualitative insights related to ergonomics, stacking, labeling, and workflow compatibility. These insights would be essential for assessing real-world feasibility and identifying unforeseen constraints.

Rather than aiming for immediate optimization, this evaluation would prioritize learning, using identified limitations (e.g., hygiene management or maintenance requirements) to inform subsequent design iterations.

5.6 Challenges of executing the process of solving the client/stakeholder case

Throughout the course of the project, several challenges emerged that shaped how we approached the research. These challenges were not only technical or informational, but also organisational and methodological, highlighting the complexity of working within a real socio-technical system.

1.0 Accessing stakeholders and scheduling fieldwork:

One of the first challenges was organising access to Uuskasutuskeskus and Humana. These organisations operate in high-volume, time-sensitive environments where staff availability is limited. Arranging interviews and site visits required patience, repeated communication, and flexibility on our part. In some cases, the time available for interviews or observation was shorter than ideal, which affected the depth of data we could collect. It also impacted our ability to organize in-person interview experiences and site visits. We had to resort to one in-person visit to Uuskasutuskeskus and an online interview with Humana. Nevertheless, these constraints also prompted us to prepare more focused questions and pay closer attention during the limited time we had with staff.

2.0 Navigating the scale and complexity of the textile system

A second challenge concerned the sheer complexity of the textile ecosystem. The system includes global production chains, local retail actors, consumer behaviours, NGO operations, municipal waste management, and international recycling markets. Initially, the scope felt overwhelming. We needed multiple iterations to narrow down our focus and select a problem formulation that was both meaningful and feasible within the time limits of the course. These

refinements were necessary to ensure we were engaging with a problem we could realistically influence.

3.0 Working with incomplete or uneven data:

Another challenge involved data availability. While NGOs like Uuskasutuskeskus and Humana shared valuable insights, their operational data is often based on estimates rather than systematically collected metrics. Additionally, Estonia lacks comprehensive public statistics on textile flows, donation quality, material compositions, and recycling habits. This meant our analysis had to combine qualitative insights from fieldwork with fragmented quantitative data from stakeholder reports, rather than relying on a fully measurable dataset.

6.0 Ideas for further development

Based on the insights gained through research and low-fidelity prototyping[20] further recommendations aim to support stakeholders evaluating scalable, realistic actions that could improve clothing donation and reuse systems in Tallinn.

6.1 Pilot Testing of Donation Infrastructure in Student Areas

One key direction for further development would be the implementation of a small-scale pilot program introducing textile donation bins in or near student-dense locations, such as Tallinn University and student dormitories (e.g., Karu 17)

Possible actions:

- Collaborate with the City of Tallinn and textile reuse organizations to temporarily install a donation bin in one selected student location.

- Monitor donation volume, quality, and frequency over a defined period (e.g., 4–8 weeks).

- Compare data with nearby existing donation points to assess the impact of proximity on student donation behavior.
- Study if people would rather donate clothes in bins close to their residency (Karu 17) or close to their study/workplace (Tallinn University)

The pilot would allow stakeholders to move from assumption-based reasoning to evidence-based evaluation, validating whether infrastructure proximity significantly increases student participation in clothing donation.

6.2 Testing Sustainable Storage Alternatives in Operational Settings

The "Better Storage Solution" prototype highlights an operational challenge that warrants further experimentation. Future development could involve testing alternative storage methods, such as Ghana Must-Go bags (durable, woven polypropylene (PP) plastic fabric bags), within real donation or sorting environments.

[20] Virzi, R. A. (1989). What can you learn from a low-fidelity prototype? Proceedings of the Human Factors Society Annual Meeting, 33(4), 224-228. https://doi.org/10.1177/154193128903300405

A possible action would be to conduct a limited trial comparing current plastic bag use with alternative reusable or textile-based storage solutions, and then evaluate the results based on durability, cost efficiency, ease of handling, and environmental impact.

Such testing would enable organizations to make informed trade-offs between cost, sustainability, and operational practicality.

6.3 Strengthening Collaboration Between Stakeholders

A significant area for further development lies in strengthening coordination between municipal authorities, policymakers, universities, student housing providers, and textile reuse organizations. Findings from the early stages of this research indicate that many of the challenges faced by textile reuse companies and non-governmental organizations are not primarily behavioral, but structural and regulatory in nature.

Interviews and secondary research suggest that strict legislation, complex regulations, and taxation frameworks place substantial pressure on organizations working with second-hand textiles. These constraints limit their capacity to sustainably manage low-quality or non-reusable clothing, while simultaneously increasing the operational costs of processing, storing, and reselling higher-quality items at accessible prices. As a result, organizations are often forced to prioritize cost-efficiency over environmental considerations, even when more sustainable alternatives are known and desired.

Further development should therefore focus on system-level collaboration, where municipal and legislative actors are actively involved in co-designing solutions rather than acting solely as regulators. This could include re-evaluating taxation policies related to textile waste, providing subsidies or incentives for reuse-oriented organizations, or introducing regulatory flexibility for pilot projects testing alternative storage, sorting, or donation infrastructures.

The “swap clothes day” was mentioned by one person on the survey, and could also be seen as a potential solution. Further research can be done to see if other people would be interested in such an alternative.

Additionally, awareness campaigns can be focused on donation quality plus why repurposing and reusing clothes is a better alternative to continuous purchase of new clothes. As identified from the respondents of our survey, some prefer purchasing new clothes at all times regardless. Creation of increased awareness on why upcycled textiles would be a safer, environmentally friendlier alternative can help reduce the occurrence of one time purchases if not completely remove it.

6.4 Recycling to meet needs

Another area for future exploration is the potential for textile transformation services that could bridge the gap between second-hand and 'new' retail. While our prototypes focus on improving donation quality and access, Abiodun's feedback highlighted an unmet need: repurposing donated textiles into items that feel 'new' rather than simply reselling them as-is. This could involve upcycling workshops, redesign services, or partnerships with designers to transform low-quality donations into desirable products, potentially creating a middle ground between organizations like Humana and fast-fashion retailers.

6.5 Addressing Upstream Consumption Patterns

While our prototypes focus on improving reuse infrastructure, they do not directly address the root cause of textile waste: overconsumption. Even with perfect recycling systems, environmental impact remains high if consumption continues to grow unchecked.

Future interventions should consider upstream solutions such as:

- **Awareness campaigns** highlighting the environmental cost of fast fashion purchases
- **Clothing rental services** for occasion wear (reducing single-use purchases)
- **Repair and alteration services** to extend the lifespan of existing garments
- **Swap events** and community sharing platforms as alternatives to new purchases
- and Abiodun’s suggestion to recycle to meet needs of individuals who want the perception and feeling of having a new item

As Merja noted in feedback, our current solutions risk increasing waste volumes if they simply make it easier to donate without addressing consumption habits. A truly circular system requires both better reuse infrastructure (our focus) and reduced material throughput (future work).

7.0 Conclusion & Reflection

7.1 What was achieved and what was not achieved

This project developed a set of low-fidelity prototypes grounded in a comprehensive understanding of the textile donation ecosystem, with particular attention to donor behavior and organizational constraints. Through a combination of desk research, field observations, mapping, surveys, and interviews, we were able to identify key structural and behavioral challenges within the current system, especially those affecting student donors.

The research process enabled the formulation of conceptual and service-level solutions addressing critical stages of the donation lifecycle, including pre-donation awareness, donation accessibility, and post-donation storage and logistics. These solutions were not designed as finalized products or infrastructures, but as evidence-informed prototypes intended to guide further testing and development. In this sense, the project achieved its primary objective of translating research insights into actionable design directions.

However, not all problems identified during the early stages of the research were addressed through fully articulated prototypes. In some cases, constraints related to time, access, or data availability limited our ability to prototype every issue in depth. Additionally, certain proposed solutions emerged primarily from observational insights and reasoning, rather than being directly validated through survey or interview data. While these ideas remain plausible and relevant, they would require further empirical testing to confirm their effectiveness.

Overall, the project achieved a strong exploratory and conceptual foundation, while acknowledging the limits of low-fidelity prototyping and the need for future iterations to move toward higher-fidelity testing and validation.

7.1.1 Reflection on circularity of textile industry in Estonia

The textile system examined in our survey responses and interactions with both Uuskasutuskesus and Humana is one that aligns closely with the circular economy model with substantial friction points that prevent full circularity for a majority of circulating textiles as examined above in our report. Most respondents and the shops already participate in key aspects of the circular textiles economy practices such as donating, reselling, reusing, and upcycling. Motivations ranging from reducing environmental impact to supporting social causes demonstrate a strong value-based foundation for circular behaviour. However, noticeable leaks including distance to donation points and uncertainty of donation quality within the system serve as barriers to full circularity. Our recommendations aim to patch these leaks, closing the loop, and pushing the system a step closer to achieving full circularity. See image below for what a fully circular system based on our recommendations will look like.

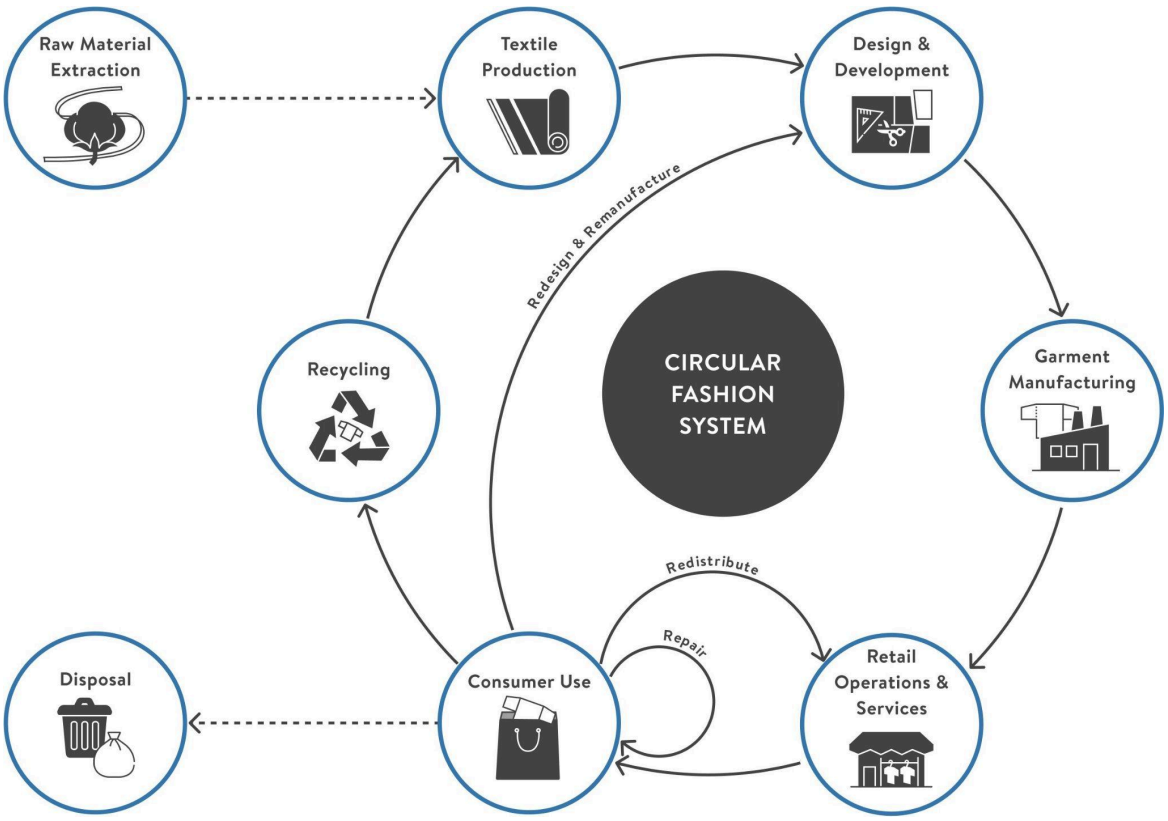

Figure VII: Circular fashion system model. Adapted from Redress Design Award (2022).

7.2. Reflect on your team's process, team members' contribution, teachers and clients'support.

The textile challenge developed as an iterative and at times demanding process for our team. At the start, the scope of the textile system in Tallinn felt difficult to grasp, especially since the assignment did not come with a fixed structure. This required us to spend time aligning our understanding of the task, clarifying expectations, and agreeing on how deeply to analyse the system. Although this slowed our initial progress, it helped us build a shared understanding and a more coherent direction for the project.

A key decision in our process was to prioritise direct engagement with stakeholders instead of relying only on desk research. Visiting Uuskasutuskeskus and establishing contact with Humana became central to how the project evolved. The site visit allowed us to observe sorting practices, storage conditions, and labour demands in practice, which made the system challenges far more concrete. These observations strongly shaped our actor network and helped us identify critical bottlenecks, particularly around donation quality and sorting capacity.

Designing and distributing interview and survey forms was another important stage. This process required iteration, as some early questions were either too broad or not sufficiently grounded in stakeholder realities. Through discussion and refinement, we improved the

clarity and relevance of the questions, which strengthened the quality of the data we collected. The interview with Humana was especially valuable, as it provided insight into organisational decision-making, seasonal donation patterns, and the handling of unsold textiles, complementing what we observed during the site visit.

As the project progressed, team collaboration became more structured. Tasks were distributed based on individual strengths, but key decisions were discussed collectively. System mapping, fieldwork analysis, ideation, and report writing were shared responsibilities, reflecting the collective intelligence approach emphasised in the course. This way of working helped us integrate different perspectives and ensured consistency across our diagrams, presentations, and written work.

Support from teachers and external stakeholders played an important role throughout the project. Feedback from lecturers helped us recognise when our analysis remained too high-level and encouraged us to deepen specific parts of the actor network rather than expanding it broadly. Openness from stakeholders during interviews and the site visit provided grounded perspectives that challenged assumptions and redirected our focus toward realistic constraints. Overall, the project strengthened our ability to collaborate under uncertainty, engage with real-world actors, and reflect critically on both our process and outcomes.

7.3. Feedback in general

Overall, the textile challenge was a practical and engaging part of the course. Working with a real societal issue in the local context of Tallinn helped make concepts such as collective intelligence and socio-technical systems more concrete. The open nature of the task supported exploration, iteration, and collaboration, while the emphasis on fieldwork and stakeholder engagement helped develop skills that go beyond theoretical analysis. Activities such as site visits, interviews, and system mapping contributed to a deeper understanding of how complex challenges take shape in real-world settings and made the learning experience more grounded and relevant.

One area where the course could be strengthened is in clarifying the connection to artificial intelligence. While the project clearly supported systems thinking, collaboration, and design-oriented analysis, the role of AI in relation to these challenges remained somewhat implicit. For students in an AI-focused programme, clearer examples or guidance on how AI tools, data-driven methods, or intelligent systems could support or interact with collective intelligence projects would help strengthen this link. Making this connection more explicit could improve alignment with the wider programme objectives while maintaining the interdisciplinary and exploratory character of the course.

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9.0 Appendix A - Detailed findings from Uuskasutuskeskus and Humana

Interview questions for Uuskasutuskeskus and Humana

QUESTIONS FOR THE SHOPS
1. Wha factors influence the pieces of clothing that are put on display in the shops?
2. what is the sorting and selection process like especially considering recycling and upcycling opportunities?
3. what do you do with clothes that you have had for far too long and have not sold?
4. what is your recycling process like? describe it
5. are there any particular pieces of clothing that are more difficult to recycle or upcycle?
6. what types of clothes do you sell the most?
7. what factors do you think influence the saleability of your most popular pieces of clothing?

The detailed insights from the interviews can be found here.

Site visit to Uuskasutuskeskus

1. Introduction

As part of the AISS SPICE textile reuse challenge, our team visited Uuskasutuskeskus, an Estonian non-profit organization focused on the collection, sorting, and redistribution of second-hand textiles. The purpose of the visit was to understand how textile reuse operates in practice and to identify the main challenges and opportunities within the local textile circular economy.

2. Second-Hand Market and Consumer Behaviour

Uuskasutuskeskus operates both standard second-hand shops and more curated "boutique"-style shops that target higher-income customers. This model demonstrates that secondhand clothing can be positioned as desirable and fashionable, not only as a low-cost alternative. Interestingly, the staff noted that consumers often prefer colorful clothing, while items such as black trousers tend to remain unsold for longer periods.

Customers also prefer to donate textiles at dedicated collection points rather than directly at stores. These collection points are strategically placed in high-traffic locations such as shopping malls and public spaces and use wall-mounted or box-style containers. The preference for collection points appears to be driven by convenience and time efficiency.

3. Collection and Sorting Infrastructure

Uuskasutuskeskus operates four main collection centers located in Tallinn, Tartu, Pärnu, and Narva. Donated textiles are transported from these centers and redistributed to stores on a

daily basis, using a logistics system that includes multiple delivery routes within Tallinn and regular shipping operations.

A significant portion of the operational work is carried out by volunteers, particularly in the sorting process. On average, one worker can sort approximately 50–60 donation bags per day, highlighting the labor-intensive nature of textile sorting. The organization handles a very high volume of donations, estimated at several thousand bags, with small items requiring especially time-consuming sorting due to handling complexity.

4. Textile Quality and Reuse Potential

Only a small portion of donated clothing is completely unusable. Approximately 5% of textiles are classified as textile waste. Around 30–40% of donations are suitable for resale in second-hand shops. The remaining items are redirected to alternative reuse pathways.

Textiles that cannot be sold are still used in social and functional ways. Some are sent to car cleaning companies where they are used as industrial cleaning cloths. Others are sent to animal-related businesses or to workshops that support people with disabilities, where textiles are used as materials to practice motor skills and support rehabilitation.

Material composition plays an important role in reusability. Natural fibers such as cotton, silk, and wool are considered high-quality and easier to reuse or recycle. In contrast, synthetic and mixed textiles such as polyester and nylon blends are much more problematic and often become part of the waste stream.

5. Economic and Regulatory Challenges

One of the most significant challenges highlighted during the visit relates to economic regulation. In Estonia, NGOs and private companies are subject to the same waste management and operational fees. This means that organizations like Uuskasutuskeskus are not allowed to sell items at lower prices than for-profit businesses, limiting their flexibility to increase access through cheaper pricing.

Waste disposal is also expensive. A major challenge for the organization is that many donors give away unsuitable or broken items, treating donation boxes as an alternative to garbage disposal. This significantly increases disposal costs, as the organization must pay taxes and processing fees for true waste.

6. Innovation, Partnerships, and Digital Systems

Uuskasutuskeskus is actively experimenting with innovation and collaboration. They have partnered with organizations such as Humana and have previously run a textile repair and stitching shop as a project, although this initiative ended last year.

They launched an e-shop during the COVID-19 pandemic, which now enables digital resale of textiles. The organization also runs reuse campaigns twice per year to raise public awareness about responsible donation and circular consumption.

7. Key Challenges Observed

Several structural challenges were identified:

- High volumes of low-quality donations
- Expensive waste management costs
- Labour-intensive sorting processes
- Limited public awareness about suitable donation practices
- Difficulty managing blended synthetic textiles

8. Opportunities for Improvement

Based on our observations, several opportunities emerged:

- Improving public education on “what is reusable vs waste”
- Supporting more efficient sorting systems
- Expanding volunteer and student engagement
- Developing better material-specific reuse pathways

9. Reflection

One particularly striking observation was how each donation bag seemed to tell a story. The range of items reflected different life moments, fashion trends, and personal histories, highlighting the emotional and social dimensions of textile waste and reuse.

Interview with Humana Textile Sorting and Reuse Operations in Estonia

1.0 Introduction

This report summarizes key insights gathered from an interview with Mina, a senior representative from Humana's textile sorting and reuse operations in Estonia. The objective of the interview was to understand the operational, logistical, and market-related dynamics of textile reuse, including sorting challenges, donation inflow patterns, consumer preferences, handling of unsold items, and the impact of regulatory changes. The conversation contributes to our broader research on circular economy practices within Estonia's textile ecosystem.

2.0 Overview of Humana's Operational Workflow

2.1 Donation Inflow and Storage Management

Humana processes very large volumes of unsorted textile donations, referred to internally as "original," arriving from both Estonia and Finland. Mina noted that donation levels fluctuate seasonally, and simultaneous collection peaks can strain storage capacity. While storage limitations do occur, the system is generally efficient due to continuous inflow–sorting–outflow cycles.

Historically, there have been rare periods where donation volumes dropped so low that sorting temporarily halted. This occurred during unusual circumstances, such as early phases of the Ukraine crisis, when donors redirected clothing toward humanitarian support instead of reuse channels.

2.2 Sorting Process and Category Complexity

The sorting center organizes textiles into approximately 30 different categories. Items are evaluated according to detailed specifications defining acceptable quality levels, fabrics, and intended reuse channels. Some categories, such as shop-quality items and shoes, undergo secondary sorting for finer classification.

Sorters receive on-site training due to the unique and specialized nature of the work. All sorted items are weighed, which allows Humana to maintain real-time stock visibility across categories.

2.3 Outflow to Shops and Partners

Humana processes around 30–35 tons, or roughly 100,000 items per day, illustrating the scale of the operation. Shops place orders by category and quantity (typically in tons rather than kilograms), and the warehouse dispatches the appropriate volumes. Operations run within a shared logistics center, making major physical expansion difficult.

However, the current size is considered optimal based on today's donation levels, sorting capacity, and economic feasibility.

3. Market Dynamics and Consumer Preferences

3.1 Color and Style Preferences

Mina highlighted that consumer tastes vary widely because Humana's clientele ranges from bargain-oriented shoppers to vintage enthusiasts to environmentally motivated customers. While Estonian fashion tends to lean toward darker colors, especially in winter, store demand is diverse.

3.2 Clothing Availability Driven by Donations

What enters Humana's shops is determined entirely by what donors give. Key observations include:

- Men's clothing appears less frequently because men typically own fewer clothing items and wear them until heavily worn.
- Baby clothes are abundant and usually lightly used.
- Children's clothes for ages 3–5 may be in poorer condition due to heavy wear.
- Brand variety fluctuates depending on donor consumption trends.
- Past imports from the US created unusual brand inflow, but rising transport and labor costs made such sourcing economically unviable.

3.3 The Rise of Fast Fashion Donations

Items from platforms like TEMU and Shein now regularly reach donation containers. Although some view them as low-quality, Humana's philosophy is that any wearable donated item deserves a chance to be reused. Polyester-based fast-fashion items cannot typically be recycled into Humana's material-recovery streams, so giving them a reuse opportunity is preferable to disposal.

3.4 Growing Interest in Natural Fibres

Customer surveys indicate increasing demand for 100% cotton, wool, silk, and other natural fibers. However, availability depends entirely on what donors originally purchased, and natural fiber items are becoming less common in new retail markets.

4. Handling of Unsold Items

Humana's shop system prevents long-term accumulation of unsold inventory. Three shop types operate on strict cycles:

- Family shops - 5-week cycles
- Vintage shops - longer cycles but category-specific
- Two-week shops - rapid turnover in smaller cities

At the end of each selling period, all remaining items are packed and returned to the sorting center, where they are re-sorted and redirected into other reuse markets outside Estonia. Once an item fails to sell during its designated period, it does not return to Estonian stores. This model avoids stagnation and ensures continuous stock refresh.

5. Regulatory Landscape and Its Effects

The most notable recent policy change is Estonia's requirement that textiles may no longer be disposed of in general waste. However, because municipal textile-waste systems are not yet fully developed, enforcement remains weak.

Key challenges include:

- Textile waste vs. reusable textiles: Humana handles only wearable items; they do *not* process textile waste.
- Waste contamination risks: Mixing damaged or dirty textiles with reusable items can spoil entire batches.
- Lack of recycling infrastructure: Even when separated, textile waste in Estonia often ends up in landfills or incineration due to a lack of viable recycling solutions.

Future national plans aim to address this gap, but current impacts on Humana are minimal.

6. Donation Volumes and External Influences

Mina explained that donation trends are driven by:

- Seasonal wardrobe cleaning cycles
- School-year clothing checks for children
- Weather changes prompting closet reorganizing
- Humanitarian crises, such as the Ukraine war, which temporarily divert donations away from reuse systems

Though sustainability awareness is rising, textile consumption continues to grow in Europe. This suggests that donation flows will likely remain high or increase, even as waste volumes rise correspondingly.

7. Conclusion

The interview highlights the complexity and scale of textile reuse operations within Estonia.

Humana's system is built on:

- Fast, detailed sorting practices
- Flexible stock management
- Strict shop turnover cycles
- Adaptation to evolving donation patterns and consumer trends

However, structural challenges remain, especially around storage limitations, fast-fashion inflows, and the lack of a national textile-waste recycling framework. These insights are valuable for understanding the broader circular economy landscape and identifying

opportunities for improved textile recovery, community engagement, and sustainable material management.

10.0 Appendix B - Analysis of the Data Collected from the Survey of Individual Consumers

Survey questions for residents

QUESTIONS FOR PEOPLE
0. personal information. ocupation, gender, age group (0-20, 21-40, 41-60, 61+)
1. what options best describe your values when it comes to clothing choices?
a. price, comfort, trends, fashionability, longevity,
2. What do you do with items you no longer want or need?
3. If you had an option to recycle and upcycle your clothes, how open would you be to using it?
4. how frequently do you buy clothes (first-hand, second-hand)?
5. what is your preference (color/textile) when it comes to buying clothes?

The survey form can be found here.

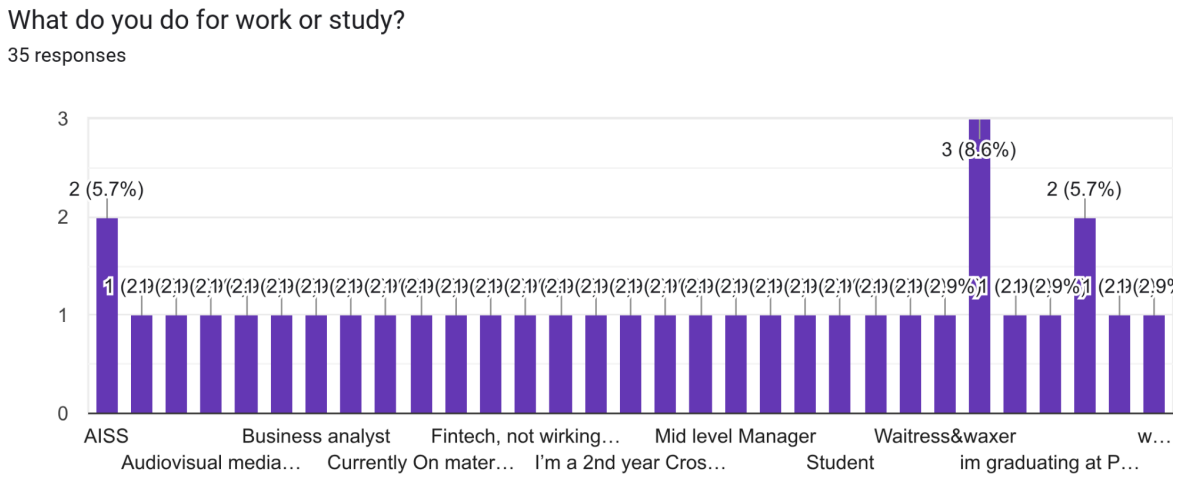
1. Introduction

We received 35 survey responses from individuals all over Tallinn to our Google form survey on Clothing Habits and Upcycling. The objective of the form was to collect information on the individual habits of textile consumers with a focus on their recycling choices with the goal of deciphering how these habits can be aligned with the problems that recycling and upcycling shops like Uuskasutuskeskus and Humana face. The overall goal is to develop an alignment between the choices of consumers and the services provided by the shops to enhance synergy to:

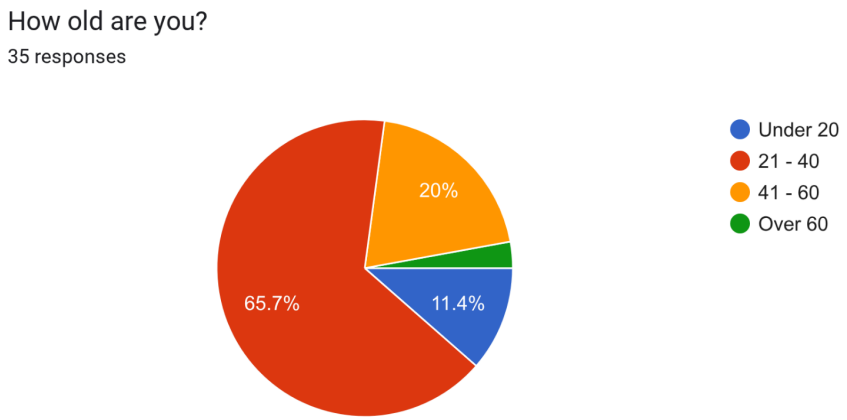
- develop practical and feasible solutions (discussed in the next chapter) to the problems (analyzed above) faced by upcycling and recycling shops.
- develop strategies that encourage consumers to engage in more frequent and convenient recycling of textiles to reduce textile waste.

2. In-depth Overview of the Questions and Responses on the Form

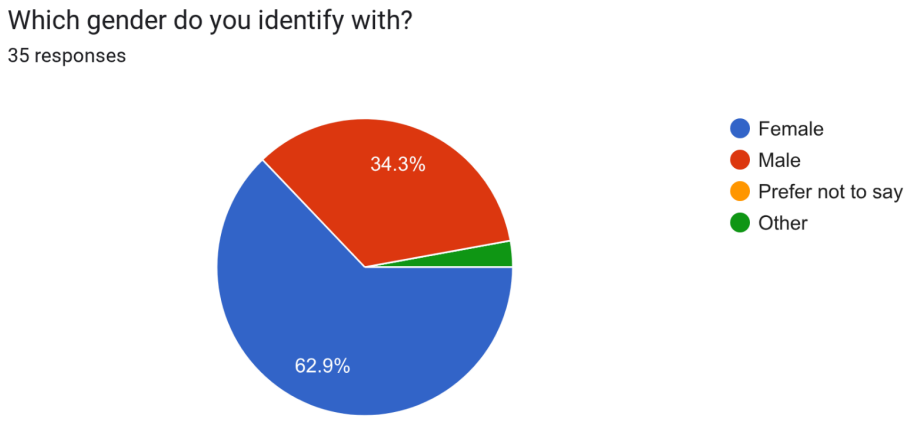
2.1.0 Demographic questions



This question sought to understand the demography of survey respondents with the aim of deciphering if there is any significant divergence between the purchasing habits of employed individuals compared to students compared to students who both work and study. It was also aimed at understanding if respondents' education level has an impact on their purchasing or donation habits and how to tailor solutions that would be appropriate in such scenarios if they occur. Additionally, it is representative of our Actor Network Theory (ref) that examines the actions of different actions in the chain dependent on context.

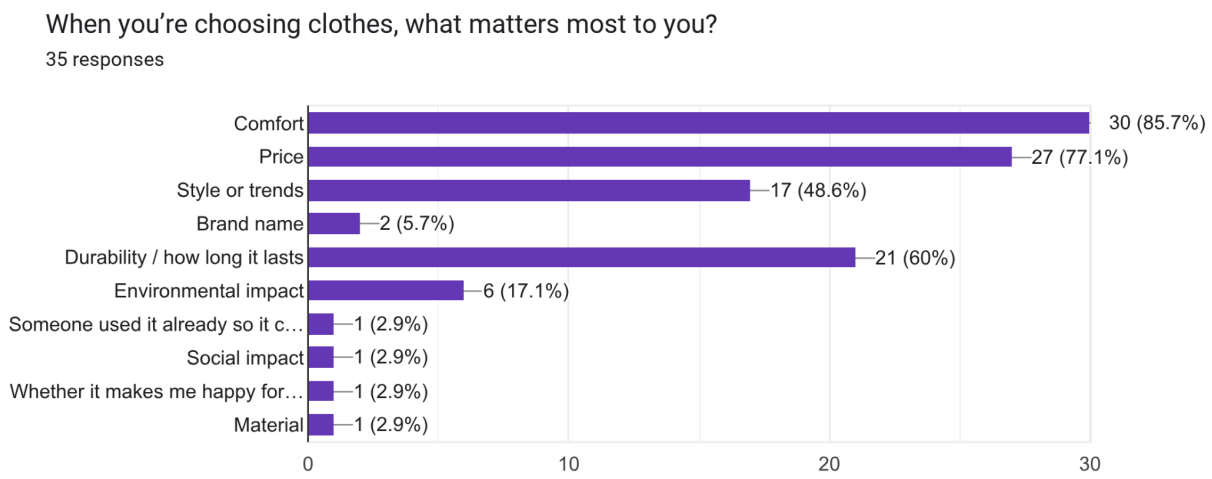


This question was aimed at discovering if age differences had any meaningful impact on the recycling habits of respondents. We also wanted to find out what the issues different age groups encounter while engaging in recycling and how to best address those concerns.



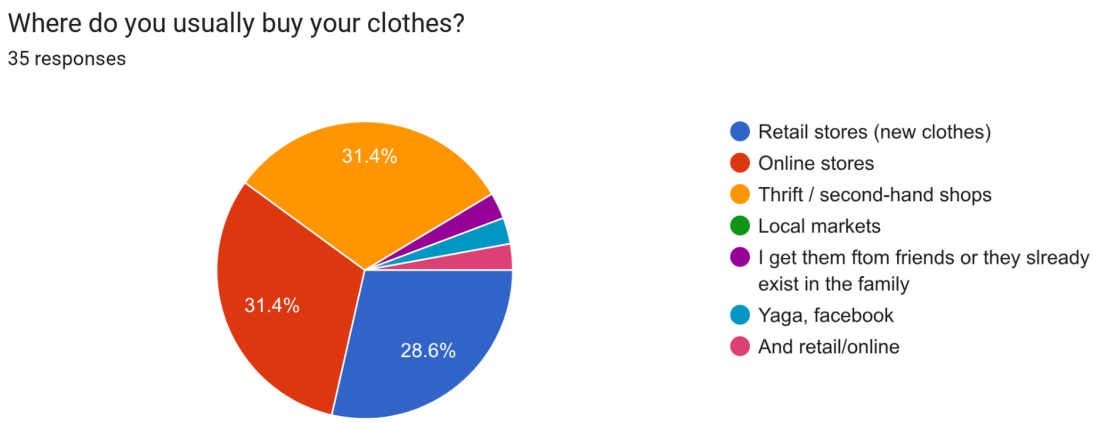
Our aim with this question was to understand if gender plays a role in the recycling habits of respondents. This was also necessitated due to our findings from the shops on the existence of much larger women's sections in thrift stores compared to men's sections which is a sentiment shared by a respondent as well. The goal was to examine if some solutions can be gender specific to encourage recycling among that gender in case a correlation can be drawn between reduced recycling habits and gender.

2.1.1 Clothing Choices and Shopping Habits



This question sought to understand what drivers factor into respondents decision making processes when it comes to choosing the types of clothes they purchase. It was necessitated by our findings from the shops that some clothes sell more than others which leads to increased waste from the clothes individuals do not usually prefer for purchase.

The aim of this question was to examine if there is a correlation between how often individuals purchase new clothes (whether brand new or from a reuse shop) and how often they recycle their existing clothes. The goal was to determine if more frequent purchases had a positive correlation with recycling or the inverse relationship.



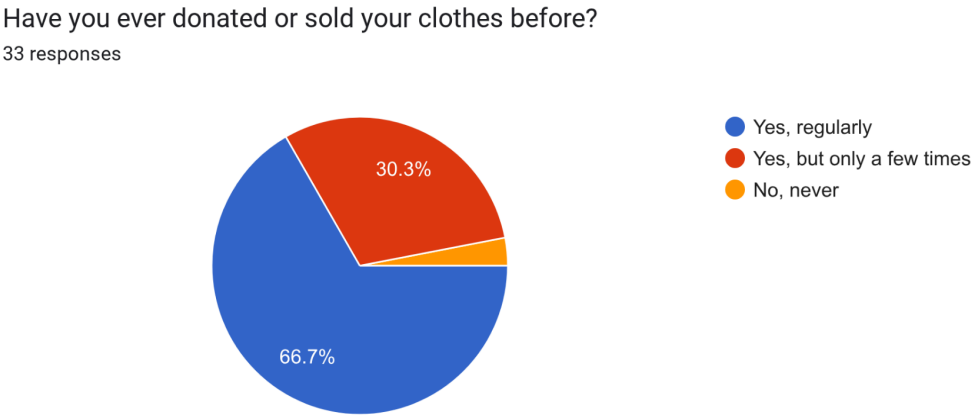
This question sought to understand where respondents usually look when opting into the purchase of clothing and whether buying from a reuse store has a strong positive correlation with recycling or if other purchase points exhibit a similar pattern or the inverse relationship.

What kind of fabrics or colors do you usually like wearing?

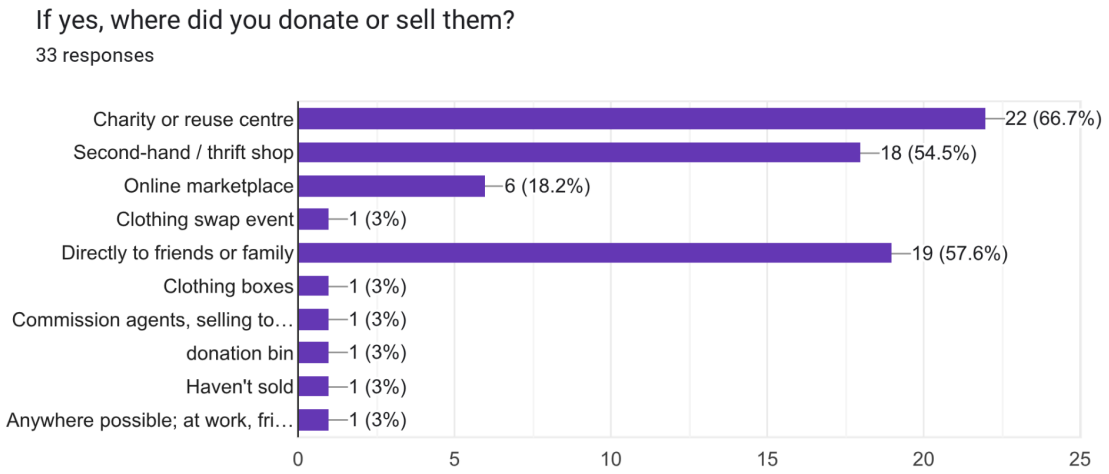
This question was aimed at understanding what the different demographics prioritize when it comes to the purchase of textiles, whether that has a correlation with rate of recycling and further purchasing habits.

2.1.3 Reuse, Donation, and Recycling Habits

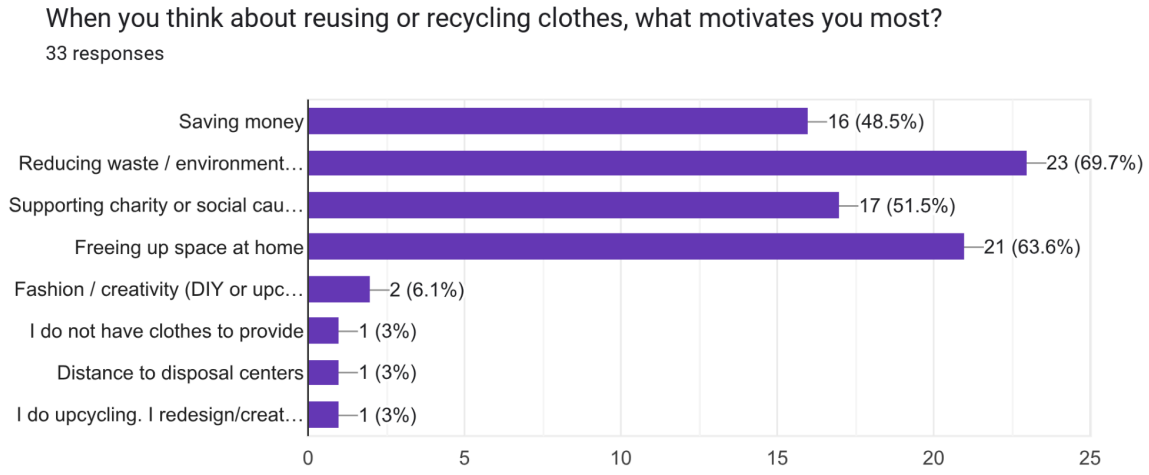
The aim of this question was to understand what respondents do with the clothes they no longer want and link that to the development of solutions to encourage recycling for individuals who are more prone to resorting to discarding textiles that can be donated for recycling.



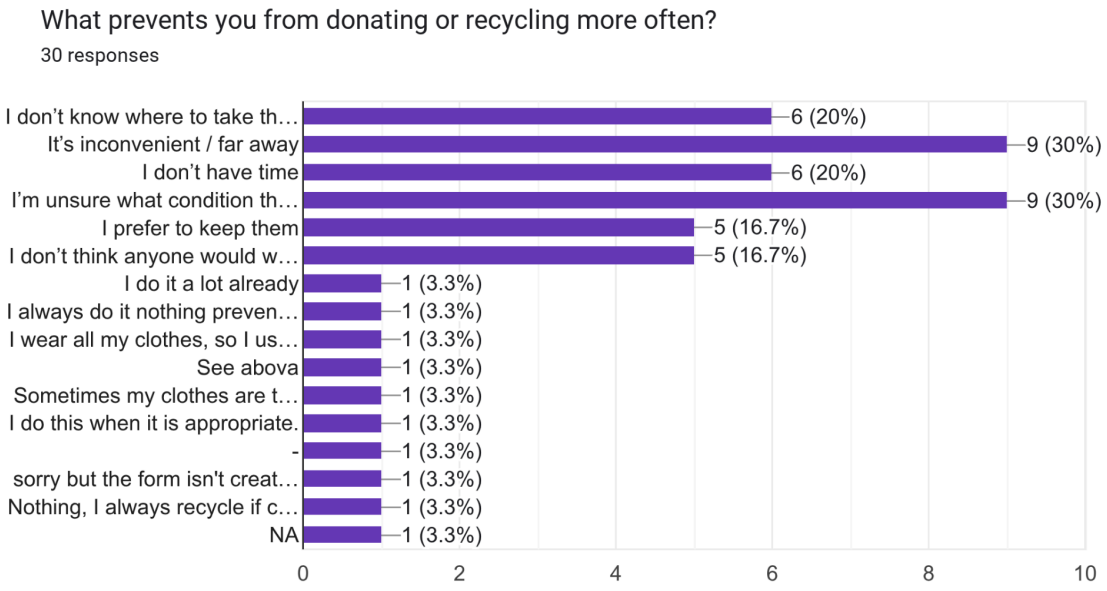
This question sought to examine the frequency at which respondents engage in donations for recycling textile items they no longer want.



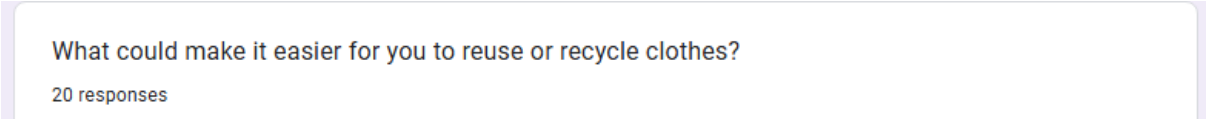
This question was aimed at examining where respondents donated items to. This is to be linked to the convenience of donations for respondents to recycling or reuse stores and organizations and how that can be enhanced through our proposed solutions.



This question sought to understand the motivations of respondents when recycling textiles and draw solutions on how to enhance these motivations to encourage recycling and reduce textile waste.

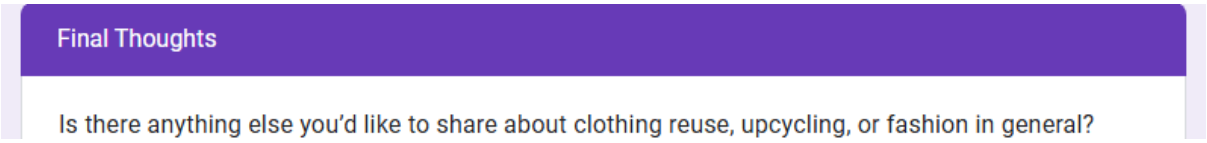


This question sought to examine the barriers respondents face when recycling so we can better understand how to alleviate these barriers.



This question sought to identify, according to respondents, solutions that could possibly enhance their ability to recycle more conveniently.

2.1.4 Final Thoughts



We also gave respondents the opportunity to share any other thoughts that our questionnaire may not have covered with us to enhance our findings.

2.2 Our findings

2.2.1 Employment status and recycling habits

We found that 71% of respondents are workers in diverse fields, 17% of respondents are students, 5.7% work and study while the rest 5.7% neither work nor study. The sample of respondents is predominantly composed of employed individuals which plays a role when it comes to interpreting the purchasing power of respondents and access-related barriers.

88% of employed respondents reported that they have donated clothes before and frequently donate to:

- charity or reuse centers
- second-hand or thrift stores
- friends or family members
- online marketplaces

This finding strongly supports the assumption that employment correlates positively with donation tendencies likely due to:

- a more stable income
- more consistent wardrobe changes

However, employed respondents also mentioned time constraints and distance/inconvenience as leading barriers to donation and recycling indicating that convenience as opposed to motivation is the limiting factor.

2.2.2 Donation behaviour by students

83% of student respondents indicate that they donate or recycle though less frequently compared to employed respondents. They tend to:

- donate irregularly
- keep clothing until fully worn out (which limits ability to donate)
- rely on friends and family

While student respondents demonstrate high environmental motivation, their lower purchasing power and volume plus access to donation options reduce donation frequency suggesting that for students, infrastructure proximity is more crucial than awareness campaigns.

2.2.3 Donation behaviour by respondents who work and study

100% of respondents who work and study donate clothing regularly. Although this sample is small, this group of respondents demonstrates the highest engagement with reuse and recycling systems. This suggests a combination of financial capacity and awareness of and exposure to sustainability discourse that may be an essential factor in reinforcing recycling habits.

2.2.4 Age and recycling habits

11.4% of respondents are under the age of 20 and:

- demonstrate a high willingness to donate
- have a strong environmental motivation
- face main barriers such as time constraint, uncertainty about condition standards of donations

65.7% of respondents are between the ages of 21 and 40. They:

- have the highest overall donation frequency
- demonstrate a strong mix of environmental, financial and space (clutter) related motivations for donation
- are most affected by convenience and time barriers

20% of respondents are from 41 to 60 with the rest 2.9% being over 60. They:

- donate less frequently but more intentionally
- prefer high quality, durability, and long term use when it comes to clothing choices
- are more likely to keep clothes until worn out

This indicates that age may not necessarily reduce willingness to donate or recycle but it changes how respondents engage with recycling as:

- younger respondents tend to need access to recycling options and guidance while
- older respondents prioritize quality-first consumption, reducing waste at the source rather than through donations and recycling

2.2.5 Gender and recycling behaviour

Women, who make up a majority of our respondents:

- donate more frequently
- use a wider range of donation channels
- and are more likely to cite environmental and social motivations for donating

Men tend to:

- donate less frequently
- be more likely to cite a lack of suitable options for donation, contributing to a cyclical observance of smaller men's section in reuse stores
- have a higher likelihood of discarding used clothes when donation feels inconvenient

This data supports the assertion that gender does play a role in recycling behaviour but not in motivation. It highlights structural limitations suggesting more gender-sensitive and inclusive reuse solutions.

2.2.6 Clothing choices and shopping habits

Drivers of clothing purchases

Across all demographics, the strongest drivers for purchase were:

1. comfort
2. price
3. durability
4. environmental impact

It is observed that respondents who prioritize durability and environmental impact are significantly more likely to donate while respondents who are driven by styles or trends purchase more frequently however are less likely to stay consistent with donations or recycling.

Purchase frequency measured against recycling

We discovered that respondents who purchase clothing more frequently (every 2-3 months) are more likely to donate as they have more wardrobe turnovers. Infrequent purchase making respondents often donate less and keep clothes until worn out.

This indicates that purchasing doesn't reduce recycling, it however increases donation volumes provided that donation options are available.

Place of purchase measured against recycling
We observed that respondents who shop from thrift or secondhand stores show the strongest correlation with donating and express higher environmental motivations behind donations and purchases. While respondents who shop in first use retail shops still donate but less consistently compared to secondhand shop users and are more likely to discard textiles when donation is inconvenient.

2.2.7 Reuse, recycling, and donation habits
Respondents tend to more likely do the following with clothing items they no longer want:
- donate to charity or reuse centers
- give to friends and family
- sell online
- discard when heavily damaged

This demonstrates a clear preference for reuse over disposal provided that existing barriers are removed.

Motivations
The top motivations across all groups of respondents are:
- to reduce waste or for environmental reasons
- to free up space
- to support charity
- to save money

This indicates that environmental concern is already high but matching behaviour is constrained by logistics rather than a lack of values.

Barriers
Respondents frequently cited these as barriers to recycling and donation:
- distance to donation points
- uncertainty about clothing condition
- lack of time
- not knowing where to donate

Suggested solutions from correspondents
- Readily accessible donation bins in central locations
- clearer guidelines on acceptable clothing conditions
- pick up services for donations
- clothing swap events
- integration with existing recycling infrastructure

2.3 Conclusion
Our findings strongly indicate the following:
- workers donate the most but are limited by time and convenience
- students are willing to donate but are constrained by access and a lack of resources
- gender disparities reflect a system design, not motivation

- awareness about recycling is high but there is a lack of corresponding infrastructure

Key solutions should therefore prioritize convenience first recycling systems as opposed to behavioural change campaigns.