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Treat and Clean: A pilot study in stain removal and mending of substandard thrift store donations

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Abstract: The growing prevalence of textile waste, largely driven by the fast-fashion model, necessitates a shift towards a circular economy that prioritises the reuse of materials. In Canada, the textile donation landscape is primarily managed by charities and for-profit organisations, which often rely on public donations to generate revenue. Despite high donation rates, many items received by thrift stores are unsuitable for resale, creating challenges for organisations dependent on volunteer labour. This paper discusses the *Treat & Clean* pilot study, part of a larger investigation into the quality and type of clothing donations received in Canadian thrift stores. The project aimed to assess the feasibility of rejuvenating so-called "substandard" clothing through cleaning and repair techniques, allowing these items to be resold. In total 4946 textile items donated to two large non-profit thrift organisations at nine separate store locations within Alberta and Saskatchewan were sorted. A significant portion of the donations were deemed unfit for immediate resale. A subset of sorted items (N=2271) was analysed off-site and considered for the *Treat & Clean* pilot. The effectiveness of the pilot was evaluated by analysing the success of treatments (e.g., stain removal) and tracking the resale of treated items. Results indicate that enhancing the quality of donations through simple cleaning and repair methods can increase the likelihood of their sale, thereby promoting sustainability in local communities. This study highlights the importance of increasing consumer awareness regarding donation quality.

Introduction

Textile waste has become increasingly prevalent due to the dramatic rise in clothing production and consumption associated with the fast-fashion business model (Casey & Johnston, 2021; Roos et al., 2015). It is evident that we must shift from the linear “take-make-use-waste” model to a circular economy, where materials are valued, products are retained for as long as possible, and waste is viewed as a resource. Following in the footsteps of the EU's circular economy action plan, Canada is setting in motion to create a sustainable and resilient economy (Government of Canada, n.d.). Within any circular economy framework, prioritising the reuse of items is essential. Among various methods for reusing clothing, thrift stores play a critical role by collecting, sorting, and selling clothing, relying on donations from the public.

In Canada, the collection of used clothing and textiles is primarily conducted by charities that generate funds to support their charitable activities, as well as for-profit organisations that often depend on charities for textile collection (e.g., Diabetes Canada). Clothing, including footwear and accessories, comprises approximately 36% of revenue generated by used goods stores, more than any other product segment (Koronios, 2021). Surveys on clothing disposal methods have shown that donating clothing is one of the most common ways people dispose of their unwanted garments (Han et al., 2024; Degenstein et al., 2021; Weber et al., 2017), although this may be more prevalent in urban areas due to the greater accessibility of donations bins and collectors.

Thrift stores and charitable collectors request that clothing donations be clean and in good condition (e.g., MCC Thrift, n.d.; Goodwill Industries Alberta, n.d.). However, the reality is that many items received from the public do not meet these standards. Reportedly, only 30% of donations received by local thrift stores are deemed suitable for resale within the local store where it was donated (Degenstein et al., 2021). This situation burdens charities that depend on volunteers for labour, as managing unsaleable items requires additional action and strategies,

such as downcycling, meticulous repricing, and internal distribution (Genge & Schouten, 2021; Larsen, 2023). Additionally, this can create an emotional strain on thrift store volunteers and staff who have to decide to bin items that may still be otherwise usable (Berry, 2022).

Maintaining a certain quality of donations is crucial for ensuring customer satisfaction and reducing negative perceptions regarding the cleanliness and hygiene of used clothing (Oscario, 2023). However, cleaning and repairing donated items is often not feasible for many thrift organisations due to resources, labour costs, limited volunteer capacity, and the uncertainty of whether items will sell (McQueen et al., 2023). Nevertheless, if donations arrive in good condition, the likelihood that they will be placed on the sales floor—and subsequently sold—greatly increases, promoting reuse within local communities.

Increasing consumer awareness regarding the quality of donations could help extend the longevity of these items. Consumers have access to commercial products for cleaning and stain removal, and skills for repair can be easily acquired through online tutorials. This paper presents the *Treat & Clean* pilot study, which evolved from a broader investigation into the quantity and quality of clothing and textile donations at selected Canadian non-profit thrift stores. The *Treat & Clean* pilot project aimed to assess whether clothing donations deemed unsuitable for the retail floor could be rejuvenated through repair, stain removal, de-pilling and de-hairing, and standard cleaning procedures, ultimately allowing them to be sold in a local thrift store. This paper will cover three key aspects of the project: an overview of the condition of clothing donations from the larger study; a report on the clothing categorised as being in "substandard" condition for inclusion in the Treat & Clean pilot; and finally, an evaluation of the pilot project's success in terms of the proportion of clothing sold following the treating and cleaning process.

Methodology

Collection and sorting of C&T donations

From September 2023 to October 2024, clothing and textile donations donated at selected thrift stores in two Canadian provinces were characterised. Bags of unsorted donations were randomly chosen from bins received by two large non-profit thrift organisations at nine separate store locations within Alberta and Saskatchewan. Sorting occurred either on-site or off-site, where bags were collected and sorted in facilities at the University of Alberta. In total, 4946 textile items (1191 kg) were sorted. Of these, 2271 textile items (558.2 kg) were collected and analysed off-site. The donations sorted off-site were included in the *Treat & Clean* pilot project.

Condition of clothing and textiles (C&T)

The evaluation of the condition of the donated C&T items was informed by textile waste audit literature (Weber et al., 2023) and insights from thrift store managers collected by the research team during earlier site visits. The assessment relied on subjective criteria to determine if items were suitable for sale based solely on their condition, without considering brand or vintage status. Six categories for the condition were used: A) **brand new** and in excellent condition with original hang-tags still on; B) **excellent** condition with none or minimal signs of wear; C) **good** condition - shows some sign of wear but at an acceptable level for C&T type and does not hinder resale; D) **substandard** - the item could still be used for its original purpose but condition when donated would prevent resale, as the item may require cleaning, stain-removal or repair; E) **recycling** - the item would not be reusable in its original form, but there is still value in the fabric; F) **end-of-life** - the item is contaminated or degraded to the point there is no remaining value in the fabric/fibres. For the *Treat & Clean* pilot project only category D, “substandard,” items were included.

The issues that were present in the D category C&T were further categorised into five groups according to their repairability and the severity of the defect (see Table 1) (Brasch & Ulasewicz, 2023).

Measurement of fibre content

All items were assessed for fibre content following the fibre content label and/or scanned using near-infrared (NIR) spectroscopy (FabriTell, Matoha). When fibre content labels were missing, and the NIR scanner could not identify fibre content for various reasons, such as a lustrous surface, excessive pilling, black-and-white compact patterns, etc. (Cura & Mäkelä, 2024), then the fibre content was marked as ‘unknown’.

Category	Description
Wash/Clean	Wash or dry clean
Minor	Spot clean, repair needed on seams/hems, buttons, soaking, bleaching, light pilling that can be removed by pill remover easily, light hair attached
Major	Special stains (grease), require multiple steps for stain removal, difficult placement of damage, special fabric type, skills needed for repair (e.g., snagging, noticeable hole)
Innovative	Not repairable as is, recognisable/high-value brand, special or unique fabric, vintage
Rejection	Stain will not come out, severe pilling, damaged/hole not repairable, no value, moderate/ severe hair

Table 1. Description of the substandard textile items by treatment method. Modified from Brasch and Ulasewicz (2023)

Treat & Clean Pilot

In the *Treat & Clean* project determining the most effective treatment while balancing time and resources was required. Finding commercially available products that would be easily accessible for consumers and thrift stores for the project was necessary. The list of tools and cleaning products that were required for certain applications is provided in the Appendix (see Table A1).

Items included in the *Treat & Clean* project were returned to one of two MCC thrift stores following treatment. The first batch to the Edmonton store in October 2024 which comprised of 44 items, and the second batch (95 items) to the Saskatoon store in Saskatchewan in early January, 2025.

Every item that was treated and cleaned within the *Treat & Clean* pilot study was given a hang-tag label with a brief description of the issues that had been resolved, and any issues remaining. Figure 1 shows the front (a) and back (b) of the label. An additional smaller label (not shown) was attached which included the item code number and was to be removed at the point of sale by the cashier. These tags were then saved and collected by the research team later. Once *Treat & Clean* items were returned to the thrift store the items were priced and tagged by the stores' pricer and put out with all the regular clothing items organised by size/gender/type.

a. b.

Figure 1. Hang-tag for treated and cleaned items a. front, and b. back

Results and Discussion

Table 2 shows the 2271 textile items analysed off-site at the University of Alberta, categorised by condition. Of these, 52.9% were in excellent to good condition (i.e., A, B or C) and were returned as soon as possible to the thrift store for resale. Substandard textiles (Category D) accounted for 42.7% (N=970) of the total. These D items were further assessed for their suitability in the *Treat & Clean* pilot study.

Categories	Count	% of total
A	46	2.0
B	406	17.9
C	750	33.0
D	970	42.7
E	93	4.1
F	6	0.3
Total	**2271**	**100.0**

Table 2. Items and categories analysed off-site

Categories of substandard textiles and their defects

The dominant fibre content (i.e., greater than 50%) of the D items is shown in Figure 2. Cotton and cotton-dominant blends accounted for 49.9% of the total fibre content, followed by polyester and polyester-dominant blends at 25.4%. Regenerated cellulosic dominant fibres (mostly viscose but also including lyocell and acetate) comprised 9.0% of the fibre types. Protein-based natural fibres, including wool (N=5) and silk (N=3), only accounted for 1% of the total fibre types. In approximately 7% of the D items, the fibre content was unknown. Despite this, it was clear that alkaline cleaning solutions would be used as the primary

treatment for the majority of the cleaning processes.

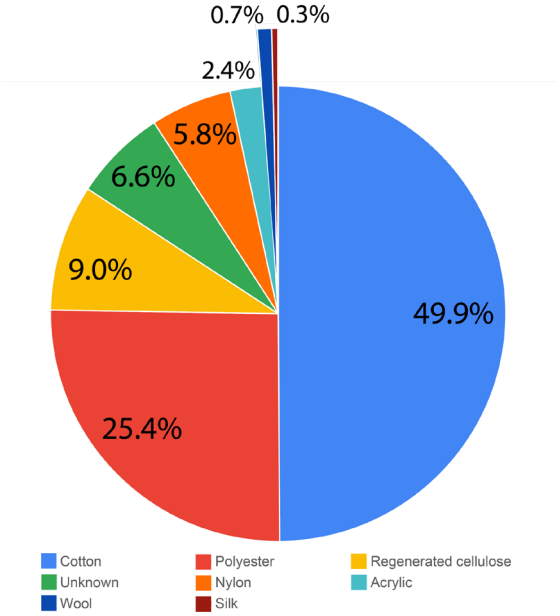

Figure 2. Major fibre components (accounted for ≥50% of the fibre content) of the inspected substandard items.

Table 3 shows the assignment of substandard but potentially reusable items categorised by the level of treatment they may require to become saleable. Those identified in the "wash/clean" category or only requiring "minor" treatment were easily treatable with a single process, such as soaking or spot cleaning, before laundering. Following this, these items would be returned in a good enough condition for sale on the retail floor. However, 29% of the items required "major" treatment. Those considered "major" had a lower repairability or required more steps in the treatment process than the "wash/clean" and "minor" categories. Rejected items constituted the largest group, and many included defects that could not be solved or had little value in resale. Table 4 describes the main reasons for rejection.

The type of textile item per treatment category is shown in Figure 3. The most common (N=379) were everyday tops, which included t-shirts, button-up shirts and women's tops. The next most common (N=218) were everyday bottoms, which included jeans, trousers, capris, shorts, etc. Activewear, socks, and underwear represented the next most common items, at N=53, N=50, and N=50, respectively. Among the everyday tops and bottoms, the proportion of items categorised as minor, major, or to be rejected were approximately the same. However, there were far higher rejection rates among underwear and socks, at 84% and 74%, respectively. The primary issues were damage, significant wear and a lack of value (i.e., used panties and single socks).

Category	Total count	% of total
Wash/Clean	49	5.1
Minor	276	28.5
Major	281	29.0
Innovative	11	1.1
Rejection	353	36.4
Total	970	100.0

Table 3. Frequency and categories of the substandard textile items sorted

Reasons for Rejection	Total count	% of total
Stain that will not come out	50	14.2
Severe pilling	120	34.0
Damaged/ Hole not repairable	137	38.8
No value	29	8.2
Moderate/ Severe Hair	17	4.8
Total	**353**	**100.0**

Table 4. Reasons for rejection of the substandard textile items sorted

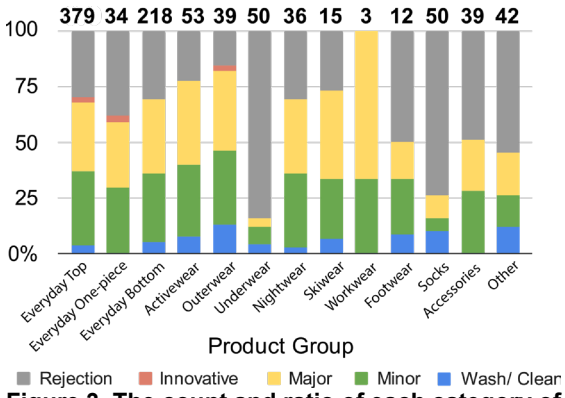

Figure 3. The count and ratio of each category of substandard textile items according to the product group

Holes, tears, and wear were the most common types of damage in substandard D items (Figure 4). Most holes could be mended, yet 42.4% of repaired holes would be noticeable or require advanced mending skills. About 52% of the "wear and tear" damage was categorised as rejection as the torn area could be time-consuming to mend, or the fabrics were more severely abraded and thinning through. Snagging, another type of repairable damage, was a complex issue requiring advanced mending skills and time. This led to 39.7% of snagged items being classified as major, and 46.6% were rejected due to long snags or numerous noticeable snags on a single item. Items with undone stitching and parts missing could be repaired in most cases. However, 26.1% of items with undone stitches and 16.7% with lost parts were rejected because the parts to replace them were unavailable, including lost buckles and buttons.

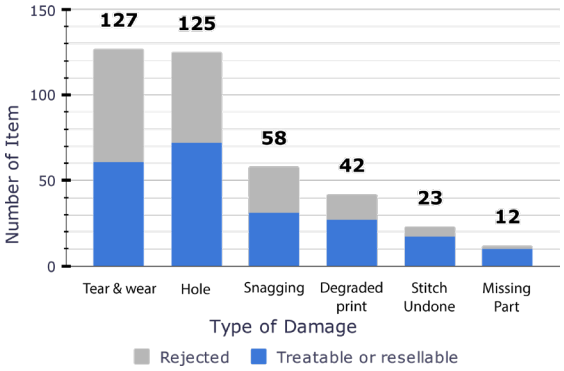

Figure 4. Overview of the repairable damage on inspected items, in which one item could contain multiple damages

Degraded prints could not be fixed, and this was another issue leading to a rejection (35.71%, N=15). Most of them were presented with cracks, peeling, or brittleness.

Figure 5 presents the types of stains found. It was not possible to identify the majority of stains through the purely sensory assessment undertaken in this project. However, some stains could be identified based on their colour, smell, texture and location on the garment. Approximately 71% (93/129) of the unidentified stains were considered treatable (i.e., wash/clean, minor, major). Perspiration and/or deodorant, as well as dirt, were the major types of identifiable stains. For these stains, about 75% of perspiration/deodorant stains and 61% of dirt stains were considered treatable. Unfortunately, the stains mentioned above were not the only reason for considering if the item was treatable. Multiple issues were found to occur on the same item, such as excessive hair and other damage. These other issues may have led to the rejection of the item despite the stain being removable.

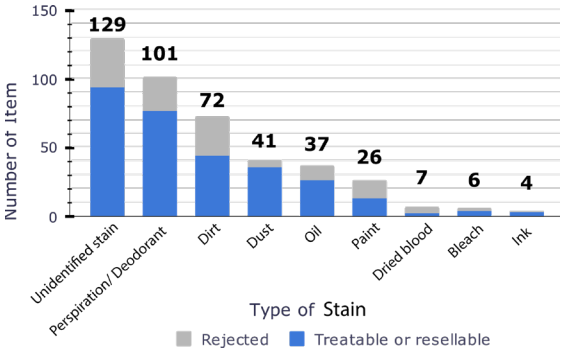

Figure 5. Overview of the potential stains on inspected items, which one item could contain multiple stains

The average processing time for the stain removal treatments was either relatively short or could be reduced by treating the garments in batches (i.e., 3-5 items soaked together). Table 5 illustrates the average treatment time for these common stains. Dirt stains could be easily removed by spot-cleaning with diluted dish soap, with a high success rate of 87.5% (Appendix Table A2). Unidentified stains, perspiration and deodorant stains were tested with multiple methods for stain removal, and soaking the stains with OxiClean™ Versatile Stain Remover was the safest and the most effective way to remove the stains. Dried blood stains accounted for only 1.5% of the total stains. Still, they could also be easily removed with hydrogen peroxide (Howard et al., 2019) with a 100% success rate (see Table A2).

Nevertheless, some stains could not be removed entirely during this study. For example, in Figure 6 a residual paint stain on a cotton dominant top is shown. While the paint on the top layer could be removed by scraping with tools after soaking them in an ammonia and vinegar mixture overnight (8 hours) (see Table 5), paint residue attached intimately to the fabric surface could not be removed, and marks remained (Figure 6). Ink was another stain that could not be removed during this project, as the ink had been absorbed within the fibres. Neither rubbing alcohol nor ammonia/detergent mixtures could eradicate

ink stains. Some ink stains faded yet were still noticeable. Since bleach removed the colour from the affected fabric/fibres, bleach marks were untreatable and not included in Table 5.

Stain	Avg. processing times (min)
Oil	53.6
Dust	5
Perspiration/ Deodorant	190
Paint	480
Dirt	10
Dried Blood	60
Ink	7.5
Unidentified stains	75

Table 5. Average treating time of each type of stain, excluding bleach stain.

Figure 6. Paint stain remaining after treatment

Treated items and samples of the treating process

As of 29 November 2024, 200 individual items had been treated for the *Treat & Clean* pilot study. Table 6 provides an overview of the success of treatments. There were 170 successful treatments, which meant that the stain(s) had been removed to the point they were no longer visible, or where repaired, the visibility of the repair was negligible. Thirty items resulted in unsuccessful outcomes, where the severity of the stain(s) may have been improved to some degree, they could not be removed completely and were still visible, or the repair was more obvious.

Total treated items	**200**
Success	170
Not Success	30

Table 6. Count of successful and unsuccessful treated items

Figure 7 illustrates the overall result by treatment category. Where treatments were successful 4.7% were wash/clean, 61.2% minor, and 34.1% major. In the instances where stains/damage were not found to have been successfully removed/repaired 40% were in the minor category and 60% major.

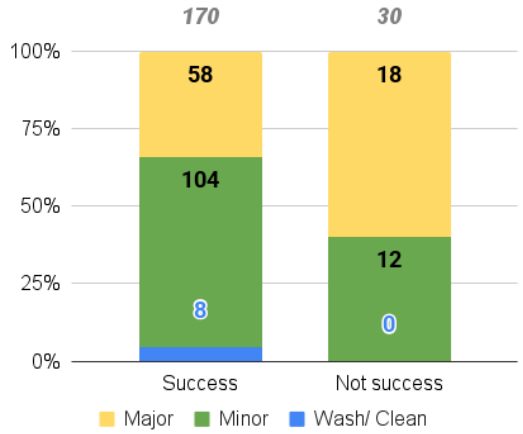

Figure 7. Count and ratio of the categories of successful and unsuccessful treatment

Examples of treated substandard items

Motor oil – One item considered to be major were a pair of shorts composed of 100% polyester. They had a dark stain that appeared to be some type of motor oil (see Figures 8a & b). Baking soda paste was applied to the stain directly and set on the stain for 30 minutes before washing. Through this treatment the motor oil stain was removed successfully (see Figure 8c).

a.


b.


c.


Figure 8. Cleaning process of item with motor oil stain

Perspiration and deodorant – Another item considered in the major category was a 100% cotton shirt (Figure 9a) that had yellowish perspiration and deodorant stains on both armpits (Figure 9b). The item was soaked with 2-3 other garments requiring similar treatment. They were soaked in 3.8 L of tap water with 113 g of OxiClean™ Versatile Stain Remover for 2 h, as per the product instructions. Following this treatment the stains disappeared (Figure 9c).

a.


b.


c.


Figure 9. Cleaning process of item with perspiration and deodorant stain.

Soaking for Textile Cleaning Before Donation

Items from the substandard D category were randomly selected for the *Treat & Clean* pilot. There were 8 items in the wash/clean category, 116 in the minor category and 76 as major. The results indicated that all three groups showed relatively high success rates for treatment: 100% for wash/clean, 89.7% for minor, and 76.3% for major, suggesting that even items

with moderate imperfections can be effectively restored with appropriate care.

OxiClean™ Versatile Stain Remover was the most commonly used tool in this study, which had a high success rate in removing oil (100%), perspiration and deodorant (100%), and unidentified stains (72.5%) (see Table A2 in the Appendix). The ingredients include sodium carbonate, which gives negative charges to the soil, especially oily ones containing fatty acid, and sodium percarbonate, which decolourises and breaks the soil, providing a high success rate in removing oil and perspiration stains (Bajpai, 2007; Nagarajan et al., 1984). With such compelling results, OxiClean™ Versatile Stain Remover and other products with similar active ingredients could assist in cleaning the majority of stains in donated clothing.

Soaking of garments can take an overall longer time, but as shown here, there is a good chance of success in removing the stains following soaking. Multiple garments with similar issues could be soaked together, allowing operators to leave the textiles to soak, followed by laundering. However, monitoring the items in the first thirty minutes is crucial to observing any colour bleeding, which could lead to pigment migration. During the study, a few items experienced pigment migration issues; some required more steps to remove pigment, and some were rejected because of these additional colourations. Given the high number of textiles with these types of stains that would be received in thrift stores than those included in the *Treat & Clean* pilot, then cleaning textiles before donation by the consumer would be optimal to avoid the extensive time and resources for cleaning in thrift stores.

Reselling Treated Textiles: Results from the Pilot Project

As of 5 March 2025, 139 items in the *Treat & Clean* project had been returned to the local thrift store. Of these, 81 items (58.3%) were confirmed as having sold (see Table 7).

	Total	**Wash/ Clean**	**Minor**	**Major**
Sent to MCC	**139**	5	87	46
Confirmed sold	**81**	3	47	31

Table 7. Count of *Treat & Clean* items sent and confirmed sold

It is possible that a few more items may have sold because some tags might not have been removed and collected by the cashier at the point of sale. If this happened, it would have occurred with the first batch of *Treat & Clean* items. In late 2024, a total of 44 items were sent back to the Edmonton store, and 17 items were confirmed to have sold. However, unsold items were not collected after the rotation period, which means it could not be confirmed what had not sold. In January 2025, 95 items were sent to the Saskatoon store, and unsold items were returned to the research team at the end of the store's five-week rotation period. From this second batch of *Treat & Clean* items, 64 items had sold, resulting in a success rate of 67.4%.

To date, the success of the *Treat & Clean* project's resale has room for growth. There is still evidence that substandard items can continue to have value after cleaning and mending, especially those requiring only a single and/or simple treatment, as 58% of sold items were soaked, sprayed, or simply mended, and 3.7% were only washed (Table 7).

In this project, 56% (N=95) of the restored textiles were cotton and cotton-dominant blends, while 22.4% (N=38) were polyester and polyester-dominant blends. Additionally, 58% (N=47) of the sold items were cotton dominant and 25.9% (N=21) were polyester dominant. With the high successful textile restoration rate in the treated items, especially in cotton and polyester dominate items, energy could be saved in their second life: only 2.6% and 1.8% the energy was consumed in the reused cotton and polyester during the process like sorting and selling, comparing to their initial status (Woolridge et al., 2006). Other research also indicates that reusing textiles could significantly extend the longevity of the textiles, and the active use length of second-hand tops could achieve 74.9% of that of the original (Laitala et al., 2024). With 51.9% of the sold items in this pilot project were tops, the result of extending the textile's longevity in this project could be promising.

Conclusions

This study highlights the potential for reusing substandard items in thrift stores. Substandard items in thrift stores still held substantial potential for reuse with appropriate treatment, even though there were shortcomings. Many items in the wash/clean and minor categories could be restored with simple processes like washing, soaking, or spot-cleaning. The result demonstrates that even lightly damaged or

soiled garments can have a second life, minimising waste and contributing to a circular economy. Furthermore, understanding common repairs and laundering issues can contribute to additional apparel design criteria considerations to address these common problems at the forefront. Attending to these problems at the design phase can enable design for easier repairs and/or associated laundering issues (e.g., design for modularity and design for disassembly).

Fibre analysis revealed that cotton and polyester were the most common materials in donated textiles, with alkaline cleaning solutions being the most effective treatment for these fibres. Although some items with severe damage, such as deep stains or irreparable fabric issues, were ultimately rejected, a considerable portion of the textiles could be successfully treated. Perspiration, oil, and dirt, were the most common stains found in this study, and many could be removed with targeted cleaning methods, yielding high success rates in the treatment process.

The results of this pilot project presented the significant potential for reusing and extending the lifespan of substandard textiles. Cleaned and treated items were shown to have the potential for resale in the market, even though they were initially considered damaged or stained. This study emphasises the impact of restoring substandard donated textiles, extending their lifespan, and reducing the environmental impact of textile disposal.

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Appendix

	Cleaning tools and materials	Applied on
Alkaline	OxiClean™ Versatile Stain Remover	Oil stains, perspiration/ deodorant stains, pigment, and unidentified stains
	OxiClean™ Max Force™ Laundry Stain Remover Spray	Oil stains and unidentified stains
	Baking Soda Paste	Oil stains, perspiration/ deodorant stains, and unidentified stains
	Diluted dishwashing Detergent	Dirt, dust, and oil stains
	Diluted Bleach	Stains on white garments
pH Neutral	OdoBan® Pet Oxy Stain Remover	Dried blood stains
	White Vinegar mix Ammonia	Paint stains
	Rubbing alcohol	Ink stains
Acidic	Diluted White Vinegar	Stains on protein fibres

Table A1. Cleaning tools and materials that were required for certain applications

Stain	Method	Cleaning tools/materials used	Success Rate (%)
Oil	Spot Cleaning	OxiClean™ Max Force™ Laundry Stain Remover Spray	100.0
	Soaking	OxiClean™ Versatile Stain Remover (powder) 2-4 scoops	100.0
	Paste	Baking soda paste	54.6
Dust	Washing	Diluted dish soap	100.0
Perspiration/ Deodorant	Rubbing	Diluted ammonia	100.0
	Soaking	OxiClean™ Versatile Stain Remover (powder) 2-4 scoops	100.0
	Paste	Baking soda paste	66.7
Paint	Soaking	Ammonia, white vinegar, and table salt mix	0.0
Dirt	Washing	Diluted dish soap	87.5
Dried Blood	Spot Cleaning	OdoBan® Pet Oxy Stain Remover	100.0
Ink	Soaking	Diluted ammonia and detergent mix	0.0
	Rubbing	Rubbing alcohol	0.0
Unidentified stains	Paste	Baking soda paste	27.3
	Spot Cleaning	OxiClean™ Max Force™ Laundry Stain Remover Spray	58.8
	Soaking	OxiClean™ Versatile Stain Remover (powder) 2-4 scoops	72.5
	Soaking	Diluted Bleach (for white garments)	100.0

	Washing	Diluted dish soap/ diluted white vinegar for protein fibres	50.0

Table A2. The success rate of removing each type of stain with different methods and tools