

Textile Reuse and Recycle – Final Report

Since 2018 a team at Washington State University (WSU) has sought to mitigate the environmental harms of textile over-consumption and waste by creating new opportunities for recycling and refurbishing textiles within Washington State’s circular economy. The end goal has been to extend the lifespan of cotton textiles, minimize the massive production of virgin cotton fibers, and reduce the volume of cotton textile waste ending up in landfills. Our previous research suggests that opportunities to reuse and recycle copious quantities of linens (sheets and towels) may exist within the hotel and hospitality industry. To explore this opportunity The Washington State Department of Commerce tasked WSU with investigating the state of textiles within the hospitality industry, including analyses of textile quality and downcycling opportunities, and assessing policies aimed to boost sustainability and circularity of market textiles. This report serves as an executive summary of our work within the project’s five deliverables, and our recommendations for further study.

This project was implemented, and the report prepared by the following project team:

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Deliverable 1: Estimate the number of hotel linens discarded in Washington State

To fulfill this deliverable, WSU researchers collaborated with the Washington Hospitality Association (WHA) to create and issue an online survey via Qualtrics. We collected data over a period of three months on hotel cotton textile disposal (costs and quantity disposed of) and willingness to pay a premium (Y/N) for recycled cotton textile supply, all other things being equal. Researchers were unable to gather quantitative data for linen purchasing by hotels. The survey was structured as follows: a) informed consent, 2) questions about a respondent’s current quantity of linen use and standards for linen purchasing, 3) questions about one’s current process for linen disposal and quantity disposed of, and 4) a question about one’s willingness to pay a premium for recycled circular cotton linens and their likelihood of participating in the “linen reuse market.”

The survey was developed with the input of subject-matter experts and informed by one small pilot survey (n=7) and two focus groups (n=2, n=13). The study was reviewed by WSU’s Institutional Review Board and certified as exempt on February 23, 2023 (WSU IRB #19849). In total, survey data from 37 hotels presented three findings.

- 1) Consumers in this market, namely Washington hotels, are reliably unwilling to pay a premium for recycled textiles, consistent with existing literature.
- 2) While hotels downcycle, most discard their linens in landfills because of stains and tears that cannot otherwise be mended.
- 3) The number of discarded linens in the market is large enough to create an opportunity to introduce a supply of recycled textiles sold to Washington hotels and sourced from discarded commercial linens.

Deliverable 2: Evaluate market potential of discarded linens

We conducted direct outreach to potential secondary market sources of discarded hotel textiles via two methods. The first method involved contacting prominent charities, non-profits, and shelters hotels mentioned in the Deliverable 1 survey as donation destinations for their discarded linens. The second method required researchers to contact new potential secondary market consumers. Our interview with the Washington Department of Corrections yielded possibilities for reusing these linens which could potentially be implemented in the short term.

This deliverable further included a circular transportation cost analysis. Disposal transport costs can be incurred either as linens are discarded during normal business cycle operations, or as hotels completely discard their entire linen inventory during periodic renovation cycles. We investigated the average cost of transportation facilitating circular textile downcycling during normal business cycles. Future research should be done to include the same cost during renovation cycles. More research is needed to investigate the total economic costs and benefits of a circular market for cotton textiles.

Deliverable 3: Textile quality testing of discarded hotel sheets and towels compared to new linens

We conducted an analysis of the properties of discarded linens compared to new hotel linens to help gauge the suitability of discarded linens for secondary uses. Linens for our testing were collected from hotels that indicated, in our Deliverable 1 survey, a willingness to donate them to our researchers. The linens included both sheets and towels from hotels with a range of quality levels, in addition to newly purchased sheets and towels. Our lab evaluated the linens for thickness, weight, fabric density, tensile strength and elongation, tearing strength, abrasion resistance, flexibility, and water absorption.

We found that the discarded sheets and towels displayed a wide range of results in all the properties assessed. Given the limited number of samples evaluated, there was no conclusion related to the correlation between the quality of the discarded linen and the quality level of the hotel. However, the results showed the sheets and towels still had strong tensile strength. The towels were soft and had good water absorption. Although some sheets had lower tearing strength than that required in the American Society for Testing Materials (ASTM) standard specification for sheets, they were still in excellent condition for other uses, further supporting the potential for a secondary market for these linens.

Deliverable 4: Assess policies that encourage the reuse and repurposing of discarded linens

To address this deliverable, we conducted market feasibility research supported by an in-depth literature review and the hotel survey data. The study (1) analyzes the profitability of the recycling technology at different demand elasticities, (2) measures the change in consumer and producer surplus from the market shift from linear to circular production, (3) conducts cost-benefit analyses to assess the viability of industrializing circular technology to meet hypothetical demands for recycled cotton linens by WA hotels, and (4) makes economic policy recommendations for optimal implementation of the circular market. We found that the supply of cotton textiles in the circular market clears the market at a lower price and greater traded quantity than the supply of new cotton textiles in the linear market. Thus, a shift in the market towards a circular mode of supply is net beneficial to society and especially to consumers (i.e., Washington state hotels). The optimal implementation of this market shift would theoretically be via a long-spanning public initiative.

Deliverable 5: Reinvention hack-a thon with WSU students

To explore creative second uses for discarded linens we conducted a hack-a-thon, which encouraged WSU students to compete in a design competition to promote creative recycling options for discarded hotel linens. To incentivize participation, we offered a total of \$3,200 in cash prizes for the winners, donated by the Pullman Marriott hotels. Linens used by the students as raw materials for their designs were contributed by the Marriott and the Pullman Holiday Inn.

The students' entries ranged from tote bags and aprons to pool cover-ups, slippers, and pet accessories. A team of ten judges, comprised of members of our project team, staff from WSU's Office of Commercialization, and Marriott executive staff reviewed the entries for utility, originality, quantity of linens used, potential for mass production, and recyclability of the designed item. Six winning designers were selected and recognized at an award ceremony held at the Pullman Courtyard by Marriott on May 3rd. Marriott is exploring the possibility of repeating and sponsoring the hack-a-thon next year and is also planning to donate discarded sheets to AMDT to use in place of new fabrics purchased by the department and students for class projects.

Conclusion and Recommendations

We believe this project was a successful pilot investigation into the state of the Washington market for linens discarded by hotels. As a result of close ties between WSU and the Washington Hospitality Association, previously inaccessible survey data was gathered for critical analysis. Not only has our project heightened hotel interest in the sustainability and cost-savings of the circular textile market, but it has also generated interest in immediate circular market participation from significant secondary market consumers previously detached from the downcycling textile stream.

However, we have only scratched the surface of an immense topic. Success will require building new relationships, creating new networks, and designing workable systems. Multiple actors, dizzying coordination, and key market forces will all need to work in concert to create a sustainable circular economy. We do believe the current system can be improved, but it will take more time and resources than the scope of this project. We believe that each of this project's deliverables deserve further study on their own, and that future research should strive to organize and connect market actors to physically implement the framework our research expounds.

The secondary market

The issues surrounding the secondary market in particular warrant further investigation because of their extreme complexity. Both studying and addressing them fully was beyond what could be accomplished during this project. Indeed, trying to address this issue within the constraints of this project was our team's greatest challenge. As next steps in this area we recommend:

- Continued exploration with Department of Corrections regarding their ability to potentially transport, store and use quantities of linens too large for other entities.
- Explore other opportunities for how linens discarded as part of a hotel renovation cycle can be redistributed to smaller organizations and other second uses.
- Develop policies that encourage the donation or sale of linens before discarding them.

There is no single path that discarded linens will, or should, take to a secondary market. Opportunities for future study include:

- Expand the size and scope of the testing done in this project, to determine the best secondary market options for linens.

- Developing business models for commercializing products made from discarded hotel linens with continued collaboration with WSU's Innovation and Research Engagement Office, and potentially utilizing the expertise of faculty and advanced students in the WSU Carson College of Business to draft feasibility studies, breakeven analysis, and business plans.

Although hotels will be in favor of repurposing and recycling their linens, getting them to change their current practices to make textile recycling an established norm will take effort. We believe this is more likely to occur with incentives rather than penalties. We recommend further study in the following areas:

- A more detailed exploration of the cost of purchasing and discarding hotel linens.
- Key market forces which encourage sustainable linens policies.
- Municipal policies to encourage recycling and discourage discarding.
- Meaningful incentives, financial or otherwise, which encourage hotels to practice and promote linens recycling.

We would like to extend our gratitude to the Washington State Department of Commerce and the Washington State Department of Ecology for allowing us to take these next critical steps in our work. Our goal to extend the lifespan of linens, minimize the massive production of virgin cotton fibers, and reduce the volume of textile waste ending up in landfills, has made positive strides through this project. Through heightening awareness of the circular textile market, our team has laid initial groundwork for future textile waste prevention and fostering a community of engaged market stakeholders ready to manifest the theoretical benefits we outlined.

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- Pullman Holiday Inn Express