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Case Study of Zero Waste Bag Design Utilizing Pre-Consumer Upholstery Fabric Waste

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The upholstery industry generates tremendous pre-consumer fabric waste each year, which negatively impacts the environment. Upholstery waste is hard to be safely burned due to its chemical composition or buried in landfills because of its slow decomposition rate (Rissanen, 2015). Although these waste scraps are too small to be used in the upholstery industry, the large dimensions of the fabric waste are sufficient to be used for creating other types of consumer products, offering a unique opportunity for sustainable design practices. Considering the great durability of upholstery fabrics in general, the waste can be upcycled to develop products that require a high level of durability such as luggage and grocery bags.

The number of plastic bags used and disposed of each year can be significantly reduced if each consumer is well aware of its negative environmental impact and uses a reusable bag as an initial sustainability engaging activity when shopping. Therefore, this study aimed to explore a potential use of pre-consumer upholstery fabric waste through the creation of reusable grocery bags, using Barquet *et al.*'s (2016) five sustainability factors for product service system (PSS) business model as a conceptual framework. The five sustainability factors (Fs) consist of: Apply Designs for Environment (F1; e.g., reduce material, design for disassembly, optimize product lifespan), Identify Economic Value (F2; e.g., cost saving from reduced materials), Promote Behavior Change (F3; e.g., increase customer satisfaction), Act Towards Social Well-being (F4; e.g., create new jobs, regenerate local economies), and Innovate in Different Levels (F5; e.g., innovations in technology, value chain or product-service).

We first explored the process of collecting upholstery fabric waste, followed by searching for the best use of the waste, developing a line of reusable bags as a replacement for plastic grocery bags, and analyzing the waste usage and its retail product value. One of many Midwestern upholsterer companies was first contacted to procure upholstery fabric waste for this study. A total of 13 yards and 15.5 inches (234.48 ounces) of the waste destined for the landfill was donated by the company and analyzed for its potential uses. Five cohesive fabrics, centered on a color theme, were chosen for this zero-waste bag design practice. One of the researchers conducted the market research on 36 currently available tote and grocery bags to analyze their dimensions, strap length, and construction techniques. The researcher then developed a bag pattern using zero waste design approach while considering the amounts and dimensions of the fabrics obtained from the company.

Each bag was designed with one bottom and two side pattern pieces, with optional pockets and self-fabric straps. Considering the varying widths of the upholstery fabrics obtained, the researchers derived the solution of designing the bottom of each bag to curve up on all four sides. By doing so, the bottom and side pattern pieces could be manipulated to fit the fabric without causing changes in the function or final bag dimensions. The dimensions of pattern

pieces could be altered to maximize fabric usages while maintaining the precise finished bag dimension. Additionally, while cutting out the patterns, creative attention was given to utilize fabric selvages that would typically be considered waste into the design. Each upholstery fabric was considered separately and the size of pattern pieces was manipulated as needed.

This case study, using 234.48 ounces of the upholstery fabric waste, resulted in the creation of 30 bags, four with pockets and two with contrasting bottoms, with a total estimated retail value of \$1,300, determined by averaging comparable bags' retail prices on the market. Value-adding assets of the bag design (e.g., upcycling, zero waste patterning) were not considered when estimating the retail value. This zero waste bag design practice, using dumpster-bound upholstery fabrics, generated only 2.625 ounces of waste, which calculates to 98.88% of fabric usage efficiency. Of the waste, 1.75 ounces were printed selvages that were unusable for other wearable product creations. Figure 1 presents a few selected reusable bags made of the upholstery fabric waste in this study.



Figure 1. Bag samples

The reusable bag design process using the upholstery fabric waste revealed a positive linkage with four of the five S-PSS factors (Fs). The design of the bag with a removable bottom piece allows for easy disassembly and replacement of the bottom piece when it wears out, which optimizes the product lifespan (F1). Cost savings are possible twice, by the fabric provider and bag designer; companies donating their fabric waste reduce disposal fees and the zero waste design approach used in the bag design process leads to maximum fabric usage, which reduces material costs (F2). As customers are beginning to be aware of the value of sustainable products such as reusable bags, their satisfaction may increase by using these products (F3). The manufacturing of the bags in this study may create new jobs and give the local economy a new source of income (F4). Factor five, Innovate in Different Levels, is not directly connected with the scope of this study, although innovation may occur in production, technology, product-service, process or value chain.

Results of this case study suggest the cost effectiveness of this reusable bag design approach using upholstery fabric waste, which is transformable with minimal to low material costs. Considering the variety of upholstery fabric waste available in the market, further study is needed to determine optimal fabric choices to create different types of products. For a long-term business application perspective, it is crucial to develop a system to source continual and consistent fabric wastes. Findings also suggest this upholstery fabric waste should no longer be considered waste, as it performs as valuable resources for the creation of other durable products; therefore, it is crucial for the public and upholstery industry to be aware of the value of this fabric waste in the various stages of recycling, reusing, and upcycling.

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