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Saroj Yadav
Department of Apparel and Textile Science, I.C. College of Community Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Neelam M Rose
Department of Apparel and Textile Science, I.C. College of Community Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Neelam Saini
Department of Apparel and Textile Science, I.C. College of Community Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Manju Dahiya
Department of Apparel and Textile Science, I.C. College of Community Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Saroj Yadav
Department of Apparel and Textile Science, I.C. College of Community Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Sustainable management of textile waste through value addition

Saroj Yadav, Neelam M Rose, Neelam Saini and Manju Dahiya

Abstract
The textile waste is a burning environmental issue which can't be ignored. It's the time to realize the impact of textile waste which wreaks havoc in so many ways on our planet from landfill overload to water pollution, greenhouse gas emissions, chemical usage and resource depletion. To overcome this problem, consumer need to redefine their approach to fashion and embrace sustainable alternatives by limiting the consumption of textiles and adopting recycling and repurposing. The present research work was undertaken to utilize the pre and post-consumer textile waste for developing value added products. On the basis of preferences of consumers, a total of twelve products under two categories i.e. apparel and utility articles/ accessories were selected for the development of innovative products using the collected pre and post-consumer textile waste. Six top preferred products in apparel category were *Lehanga choli* (WMS 4.80), evening gown (WMS 4.70), skirt-top (WMS 4.70), ladies suit (WMS 4.70), tunic (WMS 4.60) and frock (WMS 4.30). The six top preferred utility articles/ accessories selected for product development were wall pocket (WMS 4.70), mobile kit (WMS 4.70), shopping bag (WMS 4.60), foot mat (WMS 4.50), *chapati* holder (WMS 4.30) and hand bag (WMS 4.30). The selected products were developed using the collected pre and post-consumer textile waste. An exhibition of developed products was organized, the consumers were asked to give a preferred price for buying the particular product and their market potential was assed. For apparel articles the profit quoted by the consumers ranged from 20 to 100 percent and the consumers opined that the developed utility articles/ accessories could be sold with a profit margin of 10 to 60 percent. The results highlighted that the products developed from textile waste have good market potential and the pre and post-consumer waste can be effectively utilized for product development. The women having knowledge of stitching can take it up as an income generating activity.

Keywords: Textile waste, fast fashion, repurpose, recycle, value addition, sustainability

Introduction
Fashion plays an important role in buying and discarding practices of clothes by consumers. The fashion cycle has become shorter and the market is flooded with apparel and textile goods of various styles at competitive rates. Consumers react to changes in fashion both in clothing and household textiles. Due to seasonal fashion change, clothes become outdated very quickly and this encourages the consumers to replace and dispose off outdated yet good quality garments. Economic prosperity also influences this trend. As a result, number of textile and clothing items are sometime given for charities but more typically disposed off into the trash and end up in municipal landfills. Throwing away clothes is not only wasteful but harmful for society and also create pollution problems.

Textile waste refers to any material that is leftover or discarded during the production of textiles, garment making or at the end of their useful life. This can include everything from scraps of fabric to old clothes and household textiles. After plastic and paper, textile is the third largest source of waste in many states. As per the data released by The Indian Textile Journal that more than 1 million tons of textiles are thrown away every year, most of which coming from household sources. Textiles make up about 3 percent by weight of a household bin. Only a small portion of the textile waste produced each year worldwide is recycled or used for other purposes. The remainder is disposed of in landfills or burned, which increases greenhouse gas emissions and environmental degradation (Prabhakar and Lokhande, 2023) [9].

For proper waste management and to generate the minimum amount of waste, the waste hierarchy has taken many forms over the past decade; 'Refuse, Reduce, Reuse, Repurpose and

Recycle' are the 5 Rs in the waste hierarchy. Refuse is the first element of the 5 R's hierarchy. Learning to refuse waste can take some practice but adopting this practice is the most effective way to minimize waste. Reduce is design for minimum use of energy, minimize or eliminate waste material. Reuse refers to use an item more than once without reprocessing which save time, money, energy and resources. For every item that can't be refused, reduced, or reused, try repurposing it. Many people in the green community refer to this method as upcycling. Recycle is the fifth and last component of hierarchy in which waste material is transformed into new products (Leung, 2011; https://www.roadrunnerwm.com, 2023) [7].

Repurposing/ recycling of textile was a domestic craft in India but currently there are textile clusters and small scale industries to work on rags or second hand imported clothes. It is the most feasible approach to reduce the waste by reprocessing of waste material into new or reusable product, in a manner that on the one hand some burden of solid waste on our ecosystem is lessened and on the other hand sustainability is achieved through replenishable resources. Refashion is an intervention in the 'take, make, waste' lifecycle of a garment. It is a slow growing, upcycling movement that reuses discarded clothing to produce new items for return to the fashion stream (Aggrawal and Jaiswal, 2011; Fraser, 2015) [1, 3]. The present paper aims to develop value added diversified products using pre and post-consumer textile waste.

Methodology

1. **Collection and selection of textile waste:** Textile waste in the form of damaged, cutting leftovers, defective fabrics along with discarded, damaged apparel was collected from the residents of CCS HAU, Hisar campus. The collected textile waste was sorted and selected by the investigators keeping in mind their quality and suitability for developing value added diversified products. The selected textile waste especially post-consumer waste fabrics were washed thoroughly to make them clean and free from unwanted stains.
2. **Selection of diversified products:** For the selection of products to be prepared out of collected textile waste, an exhaustive list of diversified products was prepared under two categories i.e. apparel and utility articles/ accessories. Preferential choice index was developed and preferences of ten consumers were obtained on five-point rating scale i.e. highly preferred, preferred, somewhat preferred, least preferred and not preferred scoring 5, 4, 3, 2 and 1, respectively. Weighted mean scores were calculated and on the basis of scores obtained, rank was assigned to each article. A total of twelve products i.e. top preferred six articles from each category were selected for the development of innovative products.
3. **Development of products and their cost determination:** The selected twelve (12) products were developed out of selected fabrics as per the size of available material. The selected products were replicated to utilize the collected textile waste. Hence, total 48 articles comprising of 17 apparel and 31 utility articles/ accessories were prepared. Cost of each developed product was estimated on the basis of actual cost of raw materials, labour charges and finishing expenses.
4. **Market potential of developed products:** An exhibition of products prepared out of pre and post-consumer textile waste was organized to assess the market potential of developed products, the consumers were asked to give a preferred price for buying the particular product. The selling price range for each product was computed and percent profit was calculated using the following formula:

$$\text{Percent profit} = \frac{\text{Selling price} - \text{Actual cost}}{\text{Actual cost}} \text{ X } 100$$

Results and Discussion

Preferences of consumers for apparel articles

The data pertaining to preferences of consumers regarding apparel articles incorporated in Table 1 highlight that *lehanga choli* got I rank by scoring the highest weighted mean score (4.80) followed by evening gown and skirt-top at rank II with weighted mean score 4.70 each, ladies suit with weighted mean score 4.60 at IV rank, tunic and frock got v rank scoring weighted mean score 4.30 each.

Table 1: Preferences of consumers for apparel articles

n=10

Sr. No.	Apparel articles	Highly Preferred (5)	Preferred (4)	Somewhat Preferred (3)	Least Preferred (2)	Not Preferred (1)	WMS	Ranks
1.	*Kurti*	4	2	2	1	1	3.70	IX
2.	Ladies suit	6	4	--	--	--	4.60	IV
3.	Long *kurti*	4	3	1	2	--	3.90	VII
4.	Female shirt	3	3	2	1	1	3.60	X
5.	Evening gown	7	3	--	--	--	4.70	II
6.	*Lehnga choli*	8	2	--	--	--	4.80	I
7.	Paneled Plazo	4	2	3	1	--	3.90	VII
8.	Pant-plazo	--	1	4	2	3	2.30	XVII
9.	Blouse	--	2	5	2	1	2.80	XV
10.	*Dupatta*	1	3	4	2	--	3.30	XI
11.	Jacket	2	2	2	3	1	3.10	XIII
12.	Skirt-top	7	3	--	--	--	4.70	II
13.	Jump suit	--	1	2	3	6	2.20	XVIII
14.	Poncho	3	2	1	2	2	3.20	XII
15.	Tunic	5	3	2	--	--	4.30	V
16.	Frock	5	3	2	--	--	4.30	V
17.	Baby dress	1	2	3	4	--	3.00	XIV
18.	Two piece dress	--	3	4	--	3	2.70	XVI

WMS: Weighted Mean Score; Highly Preferred: 5.00-4.21; Preferred: 4.20-3.4; Somewhat Preferred: 3.40-2.61; Least Preferred: 2.60-1.81; Not Preferred: 1.80-1.00

The preferences of consumers for rest of the apparel articles in descending order were long *kurti* and paneled plazo (WMS 3.90 each), *kurti* (WMS 3.70), female shirt (WMS 3.60), *dupatta* (WMS 3.30), poncho (WMS 3.20), jacket (WMS 3.10), baby dress (WMS 3.00), blouse (WMS 2.80), two-piece dress (WMS 2.70) and pant-plazo (WMS 2.30). Jump suit was the least preferred apparel article scoring lowest weighted mean score 2.20 at XVIII rank.

It is thus inferred that six top preferred products in apparel category were *lehanga choli*, evening gown, skirt-top, ladies suit, tunic and frock, hence selected for product development using pre and post-consumer textile waste.

Preferences of consumers for utility articles/ accessories: The data presented in Table 2 regarding preferences of consumers for utility articles/ accessories elucidate that wall pocket and mobile kit scored the highest weighted mean score (4.70 each) and got I rank followed by shopping bag at rank III with weighted mean score 4.60, foot mat at rank IV with weighted mean score 4.50, chapatti holder and hand bag got V rank scoring weighted mean score 4.30 each.

The other utility articles/ accessories preferred in declining order were college bag (WMS 4.20), tote bag and lunch box bag (WMS 4.10 each), multipurpose basket (WMS 3.80), coasters (WMS 3.70), apron (WMS 3.60), bottle cover (WMS 3.10), baby sleeping bag (WMS 2.90), clutch, laundry basket and pen stand (WMS 2.80 each). The least preferred accessory was *toran* with lowest weighted mean score 2.60 at rank XVIII.

Table 2: Preferences of consumers for utility articles/ accessories

n=10

Sr. No.	Utility articles/ accessories	Highly Preferred (5)	Preferred (4)	Somewhat Preferred (3)	Least Preferred (2)	Not Preferred (1)	WMS	Ranks
1.	Apron	3	3	2	1	1	3.60	XII
2.	Baby sleeping bag	2	1	3	2	2	2.90	XIV
3.	Bottle cover	2	2	2	3	1	3.10	XIII
4.	*Chapatti* holder	4	4	2	--	--	4.30	V
5.	Clutch	1	2	3	2	2	2.80	XV
6.	Hand bag	5	3	2	--	--	4.30	V
7.	Lunchbox bag	4	3	3	--	--	4.10	VIII
8.	Laundry basket	2	2	1	2	3	2.80	XV
9.	Foot mat						4.50	IV
10.	Wall pocket	7	3	--	--	--	4.70	I
11.	Shopping bag	7	2	1	--	--	4.60	III
12.	Coasters	2	4	3	1	--	3.70	XI
13.	College bag	4	4	2	--	--	4.20	VII
14.	*Toran*	2	1	1	3	3	2.60	XVIII
15.	Tote bag	6	2	2	--	--	4.10	VIII
16.	Mobile kit	7	3	--	--	--	4.70	I
17.	Multipurpose basket	6	3	1	--	--	3.80	X
18.	Pen stand	--	4	2	2	2	2.80	XV

WMS: Weighted Mean Score; Highly Preferred: 5.00-4.21; Preferred: 4.20-3.4; Somewhat Preferred: 3.40-2.61; Least Preferred: 2.60-1.81; Not Preferred: 1.80-1.00

Hence, it is envisaged that six top preferred utility articles/ accessories selected for product development using pre and post-consumer textile waste were wall pocket, mobile kit, shopping bag, foot mat, *chapati* holder and hand bag.

According to Devi, 2011 [2] and Kavita, 2016 [5] gents' jackets and *kurti* were most preferred apparel and selected for product development. Gupta and Saggu, 2016 [4] selected six textile products i.e. cushion cover, table mat, carry bag, wall hanging, stole and muffler on the basis of experts' preferences. These selected products were developed by crocheting, weaving and knitting techniques. The results are also in line with Sunita, 2016 [10] that the most preferred six products were ladies' *kurta*, stole, bed cover, cushion cover, tote bag and file folder as per experts' preferences.

Development of diversified products: Twelve products namely *lehanga choli*, evening gown, skirt-top, ladies suit, tunic, frock, wall pocket, mobile kit, shopping bag, foot mat, *chapati* holder and hand bag were developed using the collected pre and post-consumer textile waste. The developed products are presented in Plate- I.

Apparel Articles		
		
Lehanga-choli	Evening gown	Skirt-tops

Plate 1: Developed Products

Table 3: Market Potential of the products developed from textile waste

n=10

Developed products	Actual expenses (₹)		Quoted price (₹)	Probable profit	
	Raw material	Stitching charges		(₹)	%
Apparel articles					
Lehanga Choli	600	600	2000-2400	800-1200	67-100
Evening Gown	800	500	2000-2200	700-900	54-70
Skirt-top	50	100	200-300	50-150	100
Ladies suit	300	300	800-1000	200-400	33-67
Tunic	50	100	200-300	50-150	100
Frock	50	100	150-250	00-100	66
Utility articles/ accessories					
Wall pocket	20	50	100-150	30-80	30-53
Mobile kit	10	50	80-100	20-40	25-40
Shopping bag	40	50	100-200	10-110	10-55
Foot mat	10	50	100-120	40-60	40-50
Chapati holder	10	30	80-100	40-60	50-60
Hand bag	30	50	100-150	20-70	20-47

*Rounded off to the nearest value

Market Potential of the Developed Products: All the developed products were displayed in an exhibition and opinion of ten consumers were recorded for the price at which the developed products could be sold. The results related to market potential of developed products are presented in Table 3.

The data pertaining to probable profit for developed products contained in table indicate that the quoted profit margin of developed products varied for each product depending on the design and embellishments. For apparel articles the profit quoted by the consumers ranged from 20 to 100 percent. However, the consumers were of the opinion that the utility articles/ accessories developed from textile waste could be sold with a profit margin of 10 to 60 percent. Though the profit margin was higher in apparel articles but during the exhibitions it was found that the demand was more for utility articles/ accessories. It may be due to the reason that the cost of these articles was with in purchase capacity of consumers

and moreover these products have more utilitarian value as compared to apparel articles.

Hence, it can be concluded that the products developed from textile waste have good market potential and the pre and post-consumer waste can be effectively utilized for product development. The women having knowledge of stitching can take it up as an income generating activity.

Mayers, 2014 [8] also stated that creativity of fashion designers can enhance the upcycling of apparel waste and promote sustainability in fashion industry along with granting quality new life to textile products which have been rejected by the consumers. Tomar, 2021 [11] collected pre and post-consumer denim waste and developed 18 upcycled articles using different construction, designing and embellishment techniques. The price of the all upcycled denim articles was found to be appropriate. Consumers were enthusiastic to purchase all the upcycled denim articles and experts had a high opinion about the upcycling of discarded denim.

Conclusion

The pre and post-consumer textile waste can be effectively utilized in different combinations to prepare a wide range of value added products by designers and entrepreneurs as an income generating activity.

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