

# Current State of Textile Waste Management in Pakistan- A Case of Karachi, Pakistan

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**Abstract.** The demand for textile products has grown dramatically worldwide in recent years. However, particularly in under developed nations like Pakistan, the management of textile waste is one of the least addressed sectors. Inappropriate management of textile waste has results in numerous economic, social and environmental issues. The objective of this study is to evaluate the current state of textile waste management in Pakistan by providing insight into three different areas: awareness about the textile waste management among the educated audiences, evaluation of industry level fabric waste management system and a quantification of textile waste generated by people from various economic classes in Karachi. Site visits, structured and un-structured interviews and questionnaire-based surveys were used to collect the necessary data and information for this study. The findings show that approximately >40% of people do not even understand the idea of textile waste management and about >70% are unaware about the concept of textile waste recycling. Survey results indicate that currently the majority of the textile industries are lacking adequate arrangements and research and development in textile waste management. Every year, in Pakistan about 270,125.34 metric tons of textile waste is generated including about 19,304.58 tons from Karachi. Among the Pakistan's economic classes, the highest amount textiles are discarded by the lower income class (class C), class A+ tends to trash about 195 Kg of clothing annually, whereas classes A and B demonstrate an annual discards of 150 and 105 Kg of textile waste respectively. Textile waste generation rate in the study areas is about 1.12 Kg/person/year. Currently, the major challenges to sustainable management of textile waste in Pakistan which is the inadequate technical and financial resources and a lack of awareness.

**Keywords:** textile waste, fabrics, recycling, Karachi, Pakistan

## Introduction

Worldwide the textile sector has a demonstrated role in economic and social development and holding a distinguished position among the global manufacturing sector (Zamani *et al.*, 2015). The textile industry can be classified on the basis of type of fabrics they produce, including; (i) cotton, linen and rayon fabric derived from cellulosic materials of plants, (ii) silk and wool fabric obtained from animal skins and hair and, (iii) polyester, nylon and acrylic derived from artificially produced synthetic materials (Ghaly *et al.*, 2014).

Textile is one of the rapidly growing globally and expanding industry due to rising demands of fabric by rapidly increasing population and embracing the modern life styles and fashions. Statistics indicate that by 2021, the global production of textiles was surpassed 113 million metric tons. Out of this, the production volume of chemical fibres accounted for 88.2 million metric tons and the production of natural fibres (wool and

cotton) was 25.4 million metric tons (Industrievereinigung Chemiefaser, 2023).

Despite being one of the largest manufacturing sectors in the world, currently the textile industry is facing multiple environmental and sustainability concerns (Yang *et al.*, 2020). Textile is the second worst industry for waste generation and environmental pollution. During the entire lifecycle from raw material extraction to production and final disposal the textile sector accounts for about 10 % of the global carbon emissions (Herring, 2015). Water requirement of a typical textile industry ranges from 28-285 L for the manufacturing of 1 Kg product (Uddin *et al.*, 2023).

Currently besides the textile processing waste, the post consumption waste such as used cloths and other textile materials are also the major concern. Data shows that in 2020 approximately 108.3 million tons of post consumption textile waste was produced in the world and it is expected to reach about 300 million tons by 2050 (Industrievereinigung Chemiefaser, 2023).

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In spite of the increasing demands for recycled fabrics all over the world, a holistic textile waste recycling approach has still not been adopted. Worldwide, about 75% of post consumption textile waste ends up in landfills, about 25% is reused and only less than 1% of all textiles being recycled back into garments (Ellen MacArthur Foundation, 2017)

The global textile sector is committed to contribute the climate mitigation actions through cutting out the CO<sub>2</sub> emissions by 30 % till 2030. To support this initiative currently it is crucial to find and implement the reuse and recycling options for textile waste and reducing end-of-life options for discarded textiles (Textile Exchange, 2020)

Currently various mechanical, chemical and mixed techniques are available for textile waste recycling aiming to reduce the requirement for virgin resources and landfill garbage by reusing, re-purposing or turning textile waste into new products.

Mechanical Recycling techniques involve the breakdown of used and worn textiles into smaller components, such as fibres or yarns, using the mechanical recycling procedures including shredding, carding and spinning. These recycled components can then be used to make new textiles. This method can be used to recycle some synthetic fibers but best for the natural fibres like cotton and wool (Ribul *et al.*, 2021).

Mechanical processes of textiles recycling may be either, “fibre-to-fibre recycling” in which the used cloths and other textile materials are treated to create recycled fibres that can be converted to new textile products through mechanical process of carding, shredding and spinning or shoddy recycling which involves the breakdown of used textiles into separable fibres and subsequent production of yarns (Ma *et al.*, 2019).

Chemical techniques utilize the chemical systems and processes to convert the textile waste into new products or materials. Chemical methods are mostly used for synthetic fabrics such as nylon and polyesters etc. Currently number of chemical methods of textile waste recycling are in practice in the world (Pensupa *et al.*, 2018).

Depolymerization is the chemical process can convert the textile polymers such as nylon and polyester into their parent monomers that can be reused to produce the new fibres or textile products (Thiounn and Smith,

2020). Solvent-based recycling techniques use the chemical solvents to dissolve the textiles waste materials and separate the textile fibres from other constituents like finishes and the subsequent solution is recycled to produce new textile fibres and materials (Damayanti *et al.*, 2021).

Upcycling is the textile waste recycling techniques which involves the transformation of textile wastes into high value materials without fiber breaking such as, converting the used jeans and t shirts into modern quilts and bags (Stanescu, 2021). Thermal recycling involves the burning of textile wastes in incinerators for energy generation. Thermal recycling needs environmentally responsible burning facilities to minimize the air emissions.

Non-woven fabric production, textile to textile conversions, bio-degradation of textile wastes and donations and resales of post-consumer textile wastes are the few other methods of textile waste recycling currently being practiced in the world (Damayanti *et al.*, 2021).

Presently various advanced and innovative approaches for textile waste recycling and reuse are attracting research attentions. For example, (Boondaeng *et al.*, 2023) evaluated the opportunity of enzymatic hydrolyses of chemically pretreated cotton-based textile wastes blended with polyethylene terephthalate (PET). Results of this study proposed the maximum hydrolysis yield at 89.7%, after 96 h of incubation. Another study by (Yang *et al.*, 2022) reviewed the feasibility of some physical and chemical processes such as, “composite reinforcement”, double asymmetric centrifugation and “acid-alkaline” for recycling of bast textile wastes (bast is the fibre obtained from stems of certain flowering plants) into high value products such as, soil covering material, paper making materials and adsorbent materials.

Textile is one of the Pakistan's most important economic sectors having significant contribution in country's exports, employment, and overall economic growth. Pakistan has a long history of producing textiles, and the sector has developed over time to rank among the largest in the world (Hayat *et al.*, 2020).

According to International Trade Administration's Report (2022), textile waste accounts for the 2% of total solid waste in Pakistan. Although the Pakistan is one of the major homes for post-consumer textile waste or unwanted clothes discarded every year in European

Union (EU) and other developed countries (Sattar and Akhtar, 2023) however, presently the recycling of textile waste is not a formal sector in Pakistan. A small number of textile businesses are involved in segregation, reuse and recycling of textile waste materials. There are insufficient facilities and infrastructure for textile recycling in Pakistan making the textile waste management less effective (Azeem and Adamjee, 2023). Furthermore, in Pakistan, awareness about textile waste recycling and reuse and environmental effects of textile waste is also quite poor among the textile manufacturers, workers and consumers. The non-formal waste management and recycling activities are usually less sustainable and inefficient resulting in poor product recovery rates and significant environmental, social and health risks (Jianguo and Solangi, 2023). A dedicated institutional and regulatory framework for textile waste management is also not existed in Pakistan (Sial *et al.*, 2018). Limited financial and technical resources is one of the major hurdles to establish and expand the textile waste recycling networks, infrastructures and business in Pakistan. Moreover, there is relatively a low market demand for recycled textile products in Pakistan resulting to discourage the capital investments in textile waste recycling business. (Kanat *et al.*, 2018).

The present study has been designed to evaluate the current state of textile waste management in Pakistan. Specific objectives of the study are (i) to assess the current level of awareness about textile recycling and reuse of recycled fabric in Pakistan. (ii) Evaluate the existing industrial and household level practices of textile waste management. (iii) Determine and quantify the existing textile waste generated by various socio-economic classes in Pakistan.

## Materials and Methods

To meet the research objective the present study was conducted in three phases.

**Phase 1.** During the phase 1, a survey was conducted to evaluate the awareness related to fabric recycling and related environmental and sustainability concerns, among the educated respondents including, students from various disciplines such as, environmental studies, industrial studies, social sciences and humanities. Three higher education institutes in Karachi including, Institute of Business management (IOBM), University of Karachi (KU) and Karachi School of Art (KSA) were selected for this awareness survey. Survey data was collected

with the help of structured questionnaire containing two (2) sections, (i) Basic information of the respondents such as gender, age and education level (ii) awareness on fast fashions and fabric recycling and its related environmental issues. Both male and female respondents were included in the survey however, the proportion of females was high as they tend to be more conscious about clothing and fashions hence, expected to discard more amount of textile waste. Survey questions mainly include the awareness about basic concepts of recycling in general and fabric recycling in particular, respondents' viewpoints about the availability and use of recycled fabrics in the market, information about landfills in Karachi and Pakistan, practices of textile waste disposal and use of modern technology for textile waste recycling. A total of 480 questioners/responses were received from above mentioned three institutions. Based on the overall quality and completeness of the responses, 270 questionnaires were selected for further processing and analysis for this study. Microsoft Excel software was used for data input and further processing and analysis of the data.

**Phase 2.** The phase 2 comprises an assessment of existing textile waste management at selected industry in Karachi. It includes the estimation of one year's (January, 2022 to December, 2022) total textile waste discarded from various departments of the industry including; cutting department, article department and G9- section (wastage from rejected imported fabrics). Assessment also includes the evaluation of current framework and strategies related to textile waste handling and recycling at industry. Required data and information from the industry was collected through questionnaire based interviews, group discussions, and observational surveys accompanied by the relevant technical staff of the industry. Interviews were conducted with; managers cutting department, article department and G9 department of the industry. The interview questions mainly include; perception and acquaintance of the relevant staff with textile waste management, approximate amounts of textile waste generated from the industry, current practices and procedures of fabric waste recycling, challenges and opportunities related to waste management in industries and concerns about environmental protection and sustainability. The observatory survey was conducted at; industry's warehouses dedicated for the storage of defective and waste fabrics and subsequent recycling and management of these wastes and a walkover visit of the quality

management unit of the industry. Various industrial process related to textile waste management were observed such as, loading and unloading of scrap and waste fabrics, selling and marketing of waste textiles and other practices for the treatment and management of fabric wastes at industry.

**Phase 3.** This part of the study was designed to make a quantitative evaluation of the textile waste generated by various socio-economic classes of the Karachi. Data related to generation of textile waste was collected from four areas/sections of Karachi including; Defense Housing Authority, called section A+ (Sec A+), Gulshan-e-Iqbal (Sec A), North Nazimabad (Sec B) and Esa Nagri (Sec C). Each of the above sections corresponds to economic classes of the people residing in these areas. For example, Section A+ represents the high income group, section A represents the upper middle-income group, section B-lower middle-income group and class C represents the lower income group. This classification is based on the World Bank (WB) cataloguing of countries based on their economic status (Hamadeh *et al.*, 2023), WB blog according to which the world's economies have been assigned four income groups including high income group, upper middle, lower middle and lower-income groups.

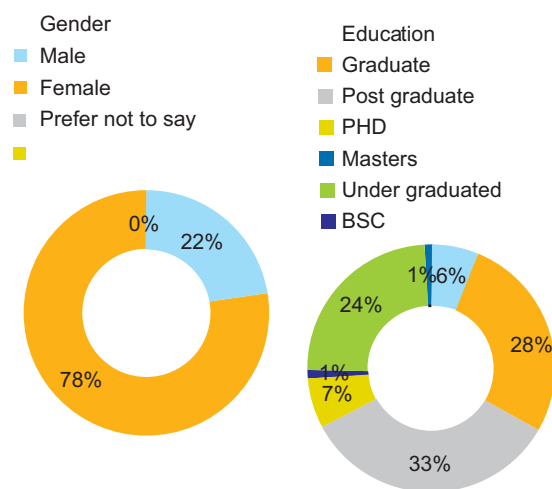
From each of the economic classes in above mentioned areas of the Karachi, 30 households were selected on random basis. From each household, approximate total number of discarded textile waste was estimated by counting the number of dresses discarded in one year by males and females belonging to all age groups including, children, adults and old age people. Textile waste data was collected with the help of structured questionnaire comprising questions such as; approximate number of fabrics including shirts, trousers and shawls etc. discarded per person per year, current practices of reuse, recycle and disposal of the discarded cloths. For each household three to four weeks' time was provided for filling out the survey questionnaire so that each family member may have sufficient time for recalling and counting the number of cloths discarded in one year. Total weight of the discarded cloths was converted to kilograms. This was done by estimating the average number of pieces of cloths in one-kilogram weight. For example, approximately 12 pieces of shirts and trousers (six dresses) discarded by children equals one kg weight and similarly the eight pieces of cloths (four dresses) discarded by adults and old ages approximately equals one kg weight. Repeated calculations were made for

estimating the one kg fabric weight by weighing multiple cloths and thus, the total weight in kilograms of discarded cloths was calculated from each economic class in selected areas of Karachi. Only the upper garments including, shirts, trousers and shawls were included in waste quantification for this study.

## Results and Discussions

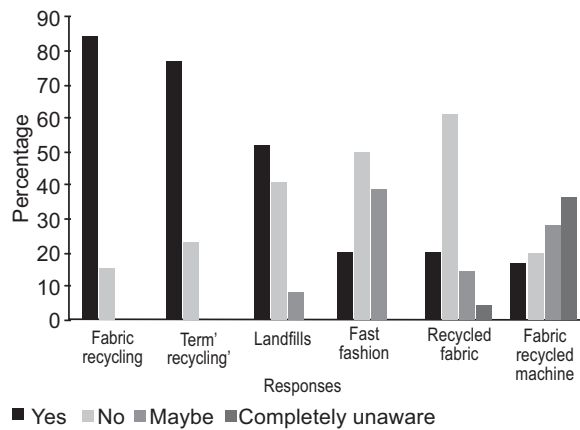
**Phase 1.** The results of the awareness survey highlight that most of the respondents were unaware or less aware of the significance of textile waste management and fabric recycling. As shown in (Fig. 1b) most of the respondents included in the survey are highly educated people including graduates, post graduates and PhD students and scholars.

Figure 2, indicates that 84.7% respondents were aware of the concept of fabric recycling and 76.9% people stated that they are aware of the term recycling. However, based on the detailed observations and in-depth analysis of the level of awareness among the respondent, we found that although, the majority of the educated people are familiar with the word "recycling". However, very few of them have proper understanding of fabric recycling and its underlying processes. This may because there are the limited awareness campaigns related to textile waste management and the poor integration of environmental concerns and textile waste recycling into the higher education curriculum and academic programs in Pakistan (Iqbal *et al.*, 2022; Davis, 2008). Figure 2 also shows that about 40% of the respondents are



**Fig. 1.** Gender (a) and educational background (b) of sampled population.





**Fig. 2.** Results of the textile waste awareness survey conducted at selected universities (Institute of Business management (IOBM), University of Karachi (KU) and Karachi School of Art (KSA) of the Karachi.

unaware of the term landfills that indicates an alarming figure. Higher education programs in Pakistan are highly specialized and most of the students only focus on their selected program of study without having sufficient exposure to other interdisciplinary matters such as solid waste management and landfilling (Murtaza and Hui, 2021). The survey results further indicate that that >70% of the people are not familiar with the recycled fabric and its benefits and about 30 % do not have any idea or knowledge about the processes and machinery related to textile waste recycling. Usually the societal behaviours and cultural norms in Pakistan less prioritize the textile recycling and sustainability practices leading to deficiency of such topics in higher education. Less prioritization of recycling and waste management in national policies may also result in less attention of these issues in higher education in Pakistan (Iqbal *et al.*, 2022).

Research demonstrates that compared to fabric recycling, the reuse of textile products including discarded cloths, is quite common in Pakistan (Sattar and Akhtar, 2023). As reported by Sandin and Peters (2018), the environmental effects of textile waste reuse and recycling are far less than the open burning and landfilling the discarded textiles.

There needs intensive efforts from both governments and higher educational institutions in Pakistan to incorporate the environmental and sustainability concerns including solid waste and textile wastes into the higher

education curriculum. Further it is also necessary to provide sufficient resources and promoting real-world experiences about the environmental sustainability among the students and the wider community. Moreover, the public awareness drives and comprehensive policy initiatives can help to develop a culture of environmental sustainability and responsibility in Pakistan.

**Phase 2.** Table 1 provides the summary of discussions including key points of conversation and responses received from the industry officials. The analysis of responses from industry personnel indicate that industry officials, despite having adequate technical capacities in their relevant fields, are less familiar with the fabric recycling and its related environmental, social and economic concerns. People interviewed were quite aware about the fact that currently Pakistan is working towards recycling PET (polyethylene tetra chloride) bottles and utilizing plastics in textile fabrics. However, they were of the view that very less efforts are being made for fabric recycling which otherwise ends up in landfills. The discussion further reveals that currently there exists no consolidated approach and mechanism for textile waste recycling within the textile industries of Pakistan including Karachi. The recycled textiles can not only be used locally but also can be exported to earn significant amounts of foreign revenues.

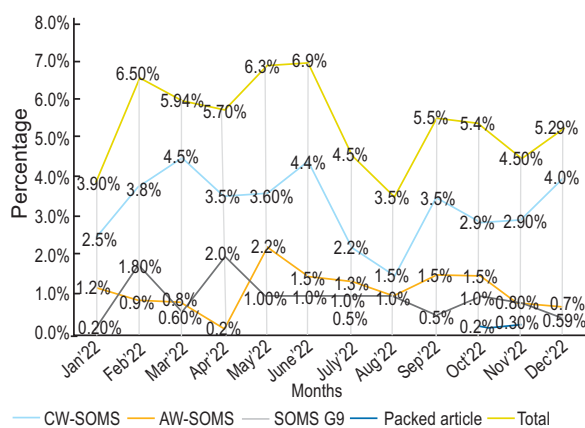
Despite the fact that discarded synthetic fibers and industrial polymers require lot of time to decompose and cause significant environmental pollution (Dris *et al.*, 2016) proper recycling, reuse and disposal of these materials is not existent in Karachi and other parts of the country. Fabric recycling not only help conserve the resources in terms of raw materials required for producing fiber, yarn and fabrics but also saves huge amounts of fresh water required to produce and process the raw materials and for textile manufacturing. Research reports that recycling back the cotton fabrics can potentially lower the water footprint by 90% (Abbas and Halog, 2021).

The data represented in Fig. 3 provides the month wise total textile waste (percentage) generated from various sections of the industry including, cutting department waste (CW), article department waste (AW) and G9 department (waste from imports) and the waste from packed articles.

As can be seen in Fig. 3, cutting department (CW) generates highest amount of waste. Waste generated by CW is in the range of 1.5 to 4.5 % during one year with

**Table 1.** Summary of discussions with officials from various departments/sections of the textile industry

Discussions	Responses		
	Cutting department	Article department	G9 department
Recycling of defective fabrics	Defected fabrics are either sold in the open market or also used as fillings in woven fabrics.	Defective fabrics mostly sold and occasionally used for fillings.	Defected fabrics can be recycled to make better ones but most of the discarded articles are sold out.
Most of the textile waste from industry is dumped in landfills instead of recycling and, landfilling creates multiple environmental problems	There are no intermediate procedures in place to recycle the discarded textiles therefore, the unsold waste mostly goes to the waste landfill.	Most of the waste is sold and remaining is dumped at landfills. Currently the recycling is highly debatable topic that could open more forums of actions within the textile industries.	There is a need of extensive research and development related to the textile waste recycling within the industries of Pakistan to minimize the landfilling of textile wastes.
Current industrial practices within textile industries of Pakistan are setting a benchmark in sustainability.	Unfortunately, currently there is lack of proper research and development in the field of textile waste recycling at textile industries in Pakistan. Economic priorities usually hinder the proper implementation of recycling policies and initiatives within the textile industries.	No practices of sustainable fabric waste management are existent in the textile industries of Karachi and overall in Pakistan	Some textile mills in Pakistan are reusing or selling the selective textile waste while, majority of waste leaving in waste dumpsites in Karachi and other cities of Pakistan including Lahore and Faisalabad.
Use of fabric recycling machinery currently being used in the world and its usage in Pakistan.	Not familiar with the fabric recycling machinery.	Not familiar with the fabric recycling machinery.	Cost benefits analysis of use of textile recycling machinery in Pakistan should be done as Pakistan being a weak economy may not afford the latest machinery for textile waste recycling.



**Fig. 3.** Fabric wastage data from different departments at textile industry. Where, CW- Cutting Wastage Department, AW- Article wastage department and G9- Wastage Section (wastage from imported textiles).

the maximum amount (4.5%) generated during the month of March, 2022. Textile wastage by article department is from 0.2 to 2.2 % from January to December, 2022 and the maximum amount was discarded in May, 2022. The G9 department generates from 0.2 to 2 % waste during the same period whereas, a very small amount of waste (0.2 to 0.3 %) comes from the packed article department.

It is evident from Fig. 3 that overall a substantial amount (maximum total about 6.9%) of textiles are wasted within the industry however, there is a highly fluctuating trends of waste production during each month of the year. It indicates a potential for minimizing the overall waste by adopting suitable measures such as proper training and education of the relevant staffs of the respective departments and by implementing the strict quality control and inventory management measures in

the industry. Industries should have in place a system of proper waste monitoring and setting up the waste reduction targets. Moreover, the industries may choose sustainable and eco-friendly raw materials, such as recyclable fibers and organic cotton having relatively less environmental issues compared to conventional materials (Lee, 2017).

**Phase 3.** In (Table 2) third phase of this research demonstrates that total about 650 Kg of textile waste is generated from 120 households from all economic classes in selected areas of Karachi. Total population of the study area is about 579 individuals hence, the average per capita textile waste in the area is about 1.12 Kg/person/year. It is equal to about 4-5 adult dresses including shirts and trousers. An extrapolation of 1.12 Kg/person/year average indicates that about 19,304.58 metric tons of textile waste may be generated in one year from entire Karachi city with the total population of 17,236,230 (17.23 million) in 2023 (World Population Review, 2023). Similarly @ 1.12 Kg/person/year the total amount of textile waste generated from entire Pakistan is about 270125.34 metric tons per year with total population of about 241,183,346 as projected by the World Population Review (2023).

It is worth mention here that per capita textile waste from rural areas of Pakistan may differ from the waste generated from metropolitan city of Karachi, therefore the above mentioned figures may not be representative of the entire Pakistan. It puts the need to conduct similar researches in rural areas as well.

It is interesting to note from Fig. 4 that currently the maximum amount of fabric waste (about 200 Kg/ anum) is being generated from the lower income group in Karachi, the upper income group being second with about 195 Kg waste/year. This may because the people from lower income groups mostly use poor quality

**Table 2.** Estimated textile waste generated from selected study area, Karachi city and Pakistan.

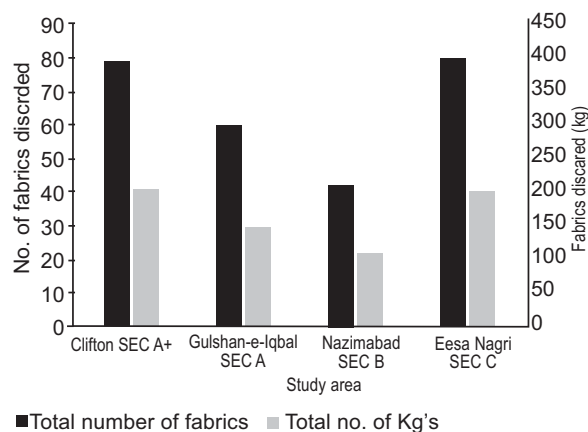
Region	Population	Textile waste (metric tons/year)
Study area (Clifton, Gulshan e Iqbal, Nazimabad and Isa Nagri)	579	0.65
Karachi city	17,236,230	19,304.58
Pakistan	241,183,346	270,125.34

textiles with relatively less life spans hence, frequently be discarded. Secondly this class also use the post consumption textiles discarded by upper classes and imported from developed nations such European Union (EU). These post consumed garments may also have less lives and may need to discard more frequently.

High amounts of textile waste generated by upper income class is because most of the people in this class frequently use the fast fashions. Moreover, being financially rich, people of upper income group in Pakistan discards their cloths more frequently compared to the middle and lower middle income groups which is financially less stable. Furthermore, the mutual reuse of cloths among the families of middle and lower middle income groups is also quite common in Pakistan resulting in comparatively less amounts of textile wastes.

It was noted during the textile waste survey that most of the discarded cloths end up in landfills or burnt by the consumers. Currently the people in Pakistan should adopt the sustainable fashion choices and consumer awareness about sustainability and environmental impacts of discarded cloths and landfilling should be improved. Furthermore, textile waste collection points may be established for fabric donations and recycling instead of landfilling.

There is also need to promote the circular economy where buyers are encouraged to resell or recycle their old fabrics. Moreover, the responsible habits should be promoted among the people and excessive consumption should be discouraged. Government can play role by



**Fig. 4.** Textile waste generated by various economic classes in selected areas of Karachi, Pakistan.

enforcing regulations and policies for sustainable textile manufacturing and waste degeneration.

### Conclusion

This study finds that there is a significant lack of awareness among the educated people in Pakistan about the textile waste management and recycling. This knowledge gap is mainly because of the limited awareness campaigns and the absence of environmental concerns and textile waste recycling topics in higher education curricula.

Textile industries in Pakistan are also inadequately familiar with the textile waste recycling and its economic, environmental and social implications. Currently the textile industries in Pakistan are lacking a consolidated approach to sustainable management of textile wastes resulting to lose the economic benefits such as revenue generation through inland selling and exports of recycled textiles beside the environmental benefits of waste recycling and reuse.

In Pakistan the people from lower-income groups contribute the highest amount of textile waste. The results emphasize the need for consumer awareness about sustainable fashion choices, responsible consumptions and textiles recycling. Moreover, promoting circular economy and establishing community level textile waste collection points are the few solutions suggested to minimize the environmental concerns of the textile waste in Pakistan.

The issues caused by textile waste in Pakistan must be addressed through the promotion of an environmental sustainability and responsibility culture as well as the implementation of laws and policies for sustainable textile manufacturing and waste management. This study put the need for extensive and broader research related to textile waste generation and its management in rural areas and other parts of the country.

### Acknowledgement

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**Conflict of Interest.** The authors declare that they have no conflict of interest.

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