



MINI-REVIEW

Solid Waste Management in Textile Industry

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Received: 01 Nov 2021; Revised: 15 Nov 2021; Accepted: 30 Dec 2021; Available online: 10 Jan 2022

Abstract: Textile is one of the primary needs of human beings in the modern world. The Textile industry has a vast production capacity across the globe. Regarding the production capacity, it generates a considerable amount of solid waste. Under sustainable development, most textile industries pay attention to implementing a proper waste management system. The importance of reducing, reusing, recycling, and managing waste is motivated by the increasing cost and decreasing availability of dumping areas, and the diminishing of natural resources. The central government imposes several regulations, protocols, and structures to guide the process of textile industries towards being environmentally friendly. Most textile industries worldwide tend to establish a sustainable development department to implement the waste management process. But the main barriers to managing wastes are lack of technology, lack of equipment, and lack of consumer awareness about recycled and upcycled products. It is essential to give knowledge to consumers about the value of buying recycled and upcycled products. It will help ensure a good market for these products and motivate textile industries to manage their waste correctly.

Index Terms: Fabric waste, recycling, textile waste, toxicity, upcycling, wastewater

1 INTRODUCTION

Waste is directly affecting the human world socially, technologically, economically, and environmentally. It is essential to manage solid waste to ensure environmental protection and protect natural resources for future generations. This paper focuses on significant waste generation activities in the textile industry, basic waste management concepts used in the textile industry to implement a proper waste management system, waste management techniques, global market demand for recycled and upcycled textile products, and negative impacts on the environment from waste. It is essential to have discussions, researches, specific studies, and inventions to reduce the impact of waste on the environment.

In the textile industry, there are two significant paths to generating waste. The first path is all the production processes that create waste and the second path is employee activities that make different types of wastes. Identifying these two paths is the key to solid waste management in the textile industry [1]. In large-scale textile industries, there are thousands of employees working inside the industry. So individually, a considerable amount of solid waste is generated by them. It is essential to capitalize on those areas to identify the waste generating activities in the industry [2].

Solid waste generated by the production processes

Waste from the fabric store

Fabrics for production are stored in a fabric storehouse and dispatched when needed. These fabrics are

coming from outside sources and can be damaged or not to the required quality. Through the desired inspection process, these damaged fabrics can be identified.

Waste from the cutting room

Fabrics are issued to the cutting room by the fabric storehouse. Several sources generate solid waste in the cutting room, such as cutting waste, marker utilization, roll surplus, etc. This is a significant production process that produces waste.

Waste from the bundling room

Fabric pieces are issued to the bundling room before it goes to production floor. In here some inspection steps can be happened but not a good inspection process. Considerable amount of waste can be generated in a bundling room.

Waste from the production floor

This is the major area that generates waste. According to the operation, loader loads the production lines with fabric bundles. In here a desired inspection process is happened and defective fabric pieces are found by the operators [3].

Waste from the aqueous systems

Aqueous systems are used in the textile industry for fabric preparation steps, including de-sizing, scouring, bleaching, and mercerizing purposes. An extensive amount of water is being used in the textile industry. Especially finishing chemicals and other chemicals are applied to textile substrates from water baths. When the water is coming out from the system, it contains several pollutants. Also, faulty valves, leakages, and mismanagement of aqueous systems can generate a considerable amount of wastewater in the industry [4], [5].

Waste from the chemical process

Several chemical processes are launched in the textile industry. Chemicals are applied to the fabric for several purposes. This generates toxic chemical waste, which desperately needs to be managed inside the industry [4], [5].

2 WASTE MANAGEMENT

Waste management includes the processes and actions required to manage waste from its inception to its final disposal. When practicing waste management, most textile industries use a basic concept of waste management to implement a proper waste management system. Most textile industries use a waste management hierarchy, zero waste concepts, and 3R waste hierarchy to implement their waste management system.

1. Waste Management Hierarchy

Fig. 1 represents the waste management hierarchy and its basic steps. Also it includes some basic information about this waste management concept. In this concept, the most favorable option is 'REDUCE.' Simply, it minimizes the amount of waste produced from each production process. Disposal is the least promising option in this hierarchy. From top to bottom mainly there are five options here. Reuse, Recycle and Recover are the other three options. According to the industry and its facilities, we can apply this waste management concept to implement a proper waste management system [6], [7].

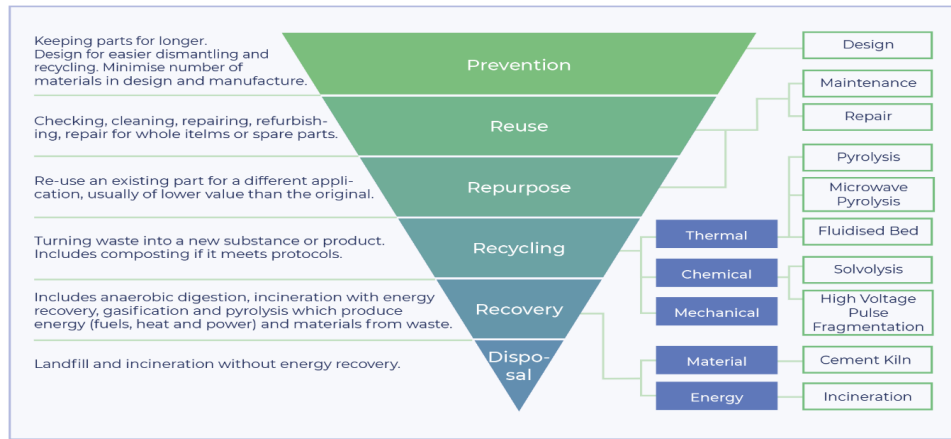


Fig. 1. Waste management hierarchy [6]

2. Zero Waste Management

In the industrial sector, the zero waste concepts are a successful concept for solving waste problems. Rather than managing waste inside the industry, this aims to eliminate waste. Also, the zero-waste concept can be defined as a systematic process of eliminating waste at the source. A closed-loop circular system is modeled in zero waste, and one-way linear resource use and disposal culture is rejected. Zero waste creates more job opportunities compared to waste incineration [8], [9].

3. 3R Waste Hierarchy

Fig. 2 shows the basic steps of the 3R waste hierarchy. The 3R waste hierarchy can be identified as a management tool to guide the allocation of resources and policy formation. The 3R waste hierarchy extracts the maximum value from already produced products and minimizes the amount of waste disposed of. This waste hierarchy grew in popularity during the early 21st century due to global environmental issues and the depletion of natural resources. 3R waste strategy generates both economic and ecological benefits [10], [11].



Fig. 2. 3R waste hierarchy [10]

Reduce

When upcoming fast fashion models and trendy products supply to the retail stores as quickly as possible, the traditional fashion retail methods are moving away. So seasonal fashion trends, fast fashion retailers constantly introduce new fashion of textile throughout the year. So social media display new styles of fast fashion Textile. As a result, customers are buying new fast fashion Textiles at a lower price. So, to reduce strategies, these textile wastes introduce education and awareness campaigns. These campaigns should be to educate customers about sustainable purchasing and use decisions. So, they can adjust their

purchasing and consumption to cultivate environmental concern and encourage by recognizing the impact of environmental degradation. So, this campaign helps to remove the connotation of consumers these textiles are disposable. It can reduce the demand for textile and reduce textile waste [12], [10], [13].

Reuse

Reuse waste focuses on reusing and used items prolonging their life. So, this extends the life of textile and its reduced water, carbon, resource, and waste footprints. The most common example for this can be described as second-hand reuse market. But the problem is there are a lot of textiles in the bales that are unsellable. So, they end up thrown out. Most countries have textile donation centers, but people through away items because they think donation center doesn't accept them. Most people appear to be lack understanding about the donation and reuse process. So, the industry focuses on two components for reuse strategy, information campaign, and collaboration. People have too low knowledge about this recycling strategy. So, the industry should expand the awareness campaign to include information on reusing textiles [10], [14].

Recycle

This involves recovering valuable raw materials from products by using chemical or mechanical recovery processes and use to make a new product. This process keeps unnecessary textile waste from landfills. The industry should develop a comprehensive collection and handling system with demand for recycled products and technologies, and second, the industry increases the investment for recycling process and support initiatives or that and doing awareness programs and discuss how the products containing recycled materials are benefited and how these products help to reduce raw materials, save energy and reduce CO₂ emissions [10], [7].

4. Zero waste management in the textile industry

This process has more employment opportunities when compared to waste incineration by; increasing recycling and reuse will reduce the production of air pollutants compared to incineration and landfilling. Industries selected a few strategies to prevent the Generation of waste. This research study was developed by addressing existing waste management strategies and issues and suggestions to achieve zero waste management goals. This Framework was developed under 3 headings as planning and design Production and sales stages. These zero waste goals mean avoiding waste before its Generation and environmental sustainability, eliminating landfilling and resource efficiency.

Planning and design stage

In this stage, there were several Organizational Strategies to prevent or minimize generation waste. So, Industries following things identified as inspecting the raw materials before sending in the production stage, preventing damage by the proper ranking system, checking goods when buying from suppliers.

Production stage

In this stage use new technological machines, giving training to employers to improve awareness. Reuse of materials, given responsible for workers and keep well-trained staff and good quality control team.

Sales stage

In this stage prevent waste generation can be summarized as increasing the utilization of cardboard, reuse and recycle of package materials. There are some issues in this stage, difficulty to increase the efficiency because of customer constraint, order issues in planning effect to the generated waste. To overcome this issue can change the opinion on customers to increase the efficiency, send back remaining

packages for suppliers, check carton quality, use reusable packages and recycle materials can minimize generation textile waste [8].

5. Upcycling off-cuts into valuable products

The procedure of cutting and separating some raw fabric materials for quality and quantitative verification of the raw fabric materials resulted in the first fabric waste generation, which began in the store. After that, the fabric inspection process was followed before production began. A random selection of 10% of raw fabric materials from each allocation is cut and segregated for color shading and shrinkage testing purposes [15]. Upcycling is a recycling technique in which a waste product is recycled into a raw material with a higher value than the original. To put it another way, upcycling is the process of changing waste material into a new product of the same or better quality than the old one. William McDonough and Michael Braungart were the first to introduce the concept of upcycling items. They proposed that, unlike recycling, there should be a procedure in which the finished product has a value that is at least equal to that of the original product [16]. Textile off-cuts can be reused for pillow stuffing, shredding, felting purposes. Nonwoven sound and thermal insulation mats can be produced from waste wool, recycled polyester. High-value added upcycled luxury handbags could be designed for fashion markets by using textiles offcuts. Insulated building material can be produced by using cotton waste and fly ash together with cement and water [16].

6. Demand for recycled textiles in world market

Numerous Technologies can streamline the textile Recycling Process, but they are commercially viable. One major thing is the investment and demand needed for recycling Textile waste. So, it can ensure a stable market for final recycling products. In the UK, there are two recycling applications. They were wiping cloths and non-woven products. These wiping cloths have a declining market. Non-woven products are mainly used for car manufacturing, mattress spring coverings that are mature markets. Textile recycling plays a significant economic role in the global marketplace while having many positive entities and significantly contributing to social responsibility. However, the textile industry can work to achieve economies of scale, reduce their overall production cost. There is a barrier to this because cheap fabric available to the textile markets. Production cost, uncertain supply chain, lower-quality fiber are additional challenges for textile recyclers in the market. However, some large retailers introduced recycled fiber into their products to ensure a stable end market that needs more demand by manufacturers [10], [17], [18].

7. Negative impact of waste on the industry and environment

7.1) Impact on Industry

The generation of waste in the textile manufacturing process is a significant challenge facing the industry. Dispose of some of the valuable raw materials used in textiles as waste also contributes to the increased production costs. Reworking, replacement production, and inspection occur wasteful handling time and effort. Increasing the percentage of waste generated also increases energy loss. It requires extra effort, energy, and cost to transport, dispose and adequately manage the generated waste. If an institute or a factory is not able to properly work this waste, it will face many legal, environmental, and social problems. It can directly affect the existence, image, and profitability of the organization. [16]

7.2) Impact on the environment

Textile industry impacts several environmental pollution problems directly and circularly.

Water Pollution

Millions of gallons of water are used in the textile industry daily. They are used for washing the fiber, bleaching, dyeing and then cleaning the finished product. Water mixed with more chemicals and other solvents during the above processes. Most dyes and chemicals used are synthetic. They are not readily biodegradable. Most of the time that wastewater is discharged into water bodies without appropriate treatment so the BOD value of water bodies is increased. This disturbs the aquatic environment and aquatic lives. [19]

Air Pollution

Gaseous wastes with solvent vapors such as ammonia and formaldehyde are normally diffused to the atmosphere from many textile industries. In addition, carbon dioxide, a powerful greenhouse gas is released into the atmosphere in significant quantities through the textile industry. The release of cotton dust into the air can be a health hazard. It can cause acute respiratory diseases and the air emissions include damage to animal life, vegetation. Furthermore, air pollution contributes to global warming and global climate change. [20]

Noise Pollution

Excessive noise has threatened the life of workers and the residential areas around them from textile manufacturing industries. High noise level causes psychological effects and physical damage, including irritability, loss of concentration, anxiety, and increased pulse rate. [21]

8. Environmental and economic benefits of managing textile waste

- As a benefit of maximizing fiber reuse reduces the cost of purchasing the material and the use of the generated solid waste for by-products such as paper production increases additional revenue and reduces the amount of waste added to the environment.
- The textile industry collects a large amount of wastewater compared to other industries. Therefore, improving the quality of wastewater contributes to reducing water pollution.
- Impact of Global Warming potential
 - Methane emission from landfills to generate electricity and CO_2 emitted by combustion can be used as a source of heating. Therefore, the effect on the environment from these emissions can be reduced and a significant amount of energy can be saved.
- 90% of discarded fiber by the consumers can be recycled. Achieving sustainable fashion can be economically viable and greatly contributes to reducing greenhouse gas emissions and has enormous environmental benefits. [22][23]

3. CONCLUSION

Pollution and harmful textile waste are increasing. Because a lot of textile release by several industries like garments, second-hand market, bales. Air, noise, water pollution is the most common environmental pollutions that can happen by textile waste. So, sustainable developed waste management system is needed for these industries. So, enterprises look forward to a 3R waste hierarchy, zero waste management options to develop textile waste management. So, the industries invest in Reuse, reduce and recycling and try to manage textile waste. And there are lots of employees work in the industry, by giving proper training and give responsible for them and improving awareness try to manage waste before they generate by zero waste management theory. Discarded waste fabrics are now new resources and wealth potential. Textile recycling plays a significant economic role in the global marketplace, and the textile industry can work to achieve economic scale by reducing its production cost. Further research is needed for analyzing and identifying an eco-friendly waste management system. The waste-to-energy approach in the textile industry could be potentially considered for waste minimize and sustainable renewable energy.

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