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Identification of the sources of fabric wastage in Garments Industry

A THESIS BY

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CHAPTER ONE

INTRODUCTION

Bangladesh is a developing nation, and the ready-made garment (RMG) industry has played a significant role in the development of the nation and its economy. Bangladesh is home to a large number of textile factories that sell premium textile goods throughout the world. According to the bureau RMG export in 2022-2023 (July-June) is $27.42 billion, whereas the previous year was $23.98 billion conducted by Monira Moula [2023]. This makes the country the second largest exporter of garments globally, with the sector accounting for 80% of Bangladesh's total export earnings reported by Nazila Fathi [2022]

Bangladesh and other developing nations are recognized for having serious environmental problems with solid waste management. Massive textile and apparel production produces a lot of solid waste and depletes raw materials supplies. Post-consumer textile waste makes up 5% of solid waste at the moment, and the majority of this waste has negative environmental effects when it is disposed of in landfills. An estimated 5,77,000 tons of waste are produced by Bangladesh's textile mills and apparel industry; 2,50,000 tons, or nearly half of the total, are 100% recyclable cotton waste with an estimated $100 million in value. As per the most recent research, the approximate amount of spinning waste is 24%, weaving waste is 35%, dyes loss is up to 2,00,000 tons, cutting loss is 10-15% and post-consumer waste is 1,000 tons conducted by Saima M. [2022] As the amount is huge, Bangladesh needs to take initiatives as early as possible. The environmental issues resulting from textile waste consist of groundwater pollution, airborne waste, dust and noise, soil degradation, greenhouse gas emissions, rainforest degradation, and so on.

Farah Tabassum, [2017] found that all parts of garment waste are valuable, recyclable, and reusable, whereas 70-80% are sold as "Jhuta" (by-product, waste fabric). Textile Today, a leading textile magazine in Bangladesh published an article on 'Jhuta' (waste fabric) processing of Bangladesh's clothing industry and mentioned that every day approximately 550 tons of garment waste are exported which is mainly generated from fabric cutting in the garments industries reported M. H. Khan, [2017]

1.1 Purpose and Significance of the Study

Nowadays fabric waste is a common phenomenon in our country. The waste from garment factories pollutes the environment. Garment waste ends up in landfills a lot. they are leading to soil and water pollution. In addition, throwing away garments in landfills not only wastes money and resources but also takes a landfill over 200 years to break down the materials. Textiles emit greenhouse gas methane during their breakdown process, and they also release harmful chemicals and dyes into our land and groundwater. By reducing the Specific amount of waste, the garment industry will highly benefit. The company will increase profits and production efficiency. Reducing garment waste can be naturally and economically profitable.

1.2 Aim of the Research

- Analyzing fabric waste in the RMG industries
- Fabric waste source identification by reanalyzing the previous data and specifying important data.

1.3 Objectives

- To identify the sources of fabric waste in the RMG industries of Bangladesh.
- To calculate a specific amount of fabric waste in every section of the garment production process.
- Show a sustainable improvement in garment factories.

1.4 Research Question

- What are the sources of fabric waste in the production process?
- What is the average amount of fabric waste in RMG industries?
- How to reduce fabric waste?
- How does fabric waste affect the RMG industries?

1.5 Research Limitations

- The research objective could be more precise if we could gather additional data. The factory prohibited us from sharing their internal data because of business policy.
- We don't have enough time to acquire all of the factory's data for our research purposes.

CHAPTER TWO

LITERATURE REVIEW

The industry faces a major problem with fabric waste, which exacerbates resource depletion, economic losses, and environmental degradation. Fabric waste can arise from various factors such as inadequate production planning, flawed quality control procedures, shifting fashion trends, and improper disposal practices by consumers.

1. **Waste before consumer:** In the textile industry, waste produced during the production process before the finished product reaches the consumer is referred to as pre-consumer waste. It comprises a variety of waste products, including trimmings, scraps, damaged parts, and unused fabric. It is waste material that has not yet reached the consumer (such as fabric and garment samples, overstock, and fabrics from roll ends) or was thrown away before it was suitable for use by consumers (such as fabrics with faulty printing, dying, or finishing) or is created while products are being made (like the fabric scraps left over after a pattern is cut out).

2. **post-consumer waste:** When people discard their clothing and textiles, fabric waste also happens. This waste could come from old, worn-out, or damaged clothing that is out of style. Instead of being fixed, donated, or recycled, these things are frequently thrown away.

   Pre-consumer fabric waste is covered in this section. During the various steps of the garment manufacturing process, fabric wastes are produced. Below is a list of them:

   1. Fabric Inspection
   2. Cutting Section
   3. Sewing Section
   4. Finishing Section
   5. Final Inspection

2.1 Defects of Fabric Inspection

Before fabric is used in production, it is inspected to determine its quality and characteristics. An essential step in the textile industry is fabric inspection. It assists in locating any flaws, irregularities, or departures from the intended standards, guaranteeing that only the suitable fabric is utilized in the production of clothing or other textile goods.

2.1.1 Shade Variation

The more noticeable visual flaw in raw textiles is called "shade variation," which is characterized by variations in color and shade depth from roll to roll or piece to piece. A fabric's shade can vary due to several factors, including:

- Fabric mixing during production
- Time and speed variations in the production process
- Inaccurate cutting, bundling
- Unequal fabric stretching

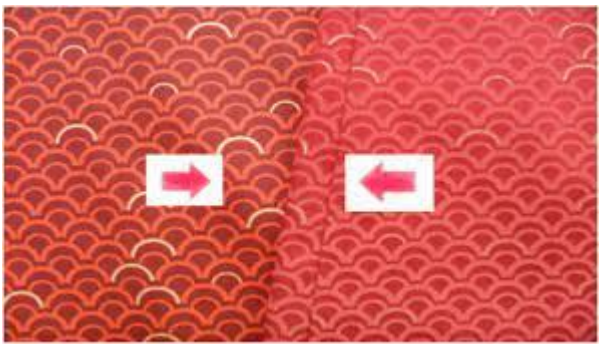


Figure 2. 1: Shade Variation

2.1.2 Horizontal Lines

This fabric defect is defined as irregular lines that run from side to side. Horizontal lines are generally caused by:

- Faults in the bobbin (the barrel used to hold the yarn in place)
- Irregular thread tension

Figure 2. 2: Horizontal Lines

2.1.3 Dirt/Stains

Spots or patches of varying colors are known as stains, and they are fairly common in textiles that have been dyed. Unfortunately, stains can happen at any point during or after production if textiles aren't stored in an area with enough protection, so they are never completely safe from them.

Figure 2. 3: Dirt/Stains

Fabrics can develop stains from almost any source. There are several recognized sources, including dyes, oil from machinery, and factory floor dirt. As long as suppliers maintain a close eye on the quality of the fabric, stains are generally simple to locate and avoid.

2.1.4 Uneven Dyeing/Printing/Dye Marks

Uneven patches on the surface of unfinished fabrics are known as dye marks. Dye marks are typically the result of:

- Low-quality base fabric
- Improper leveling agents
- Incorrect pH in the production process
- Dye machine entanglement

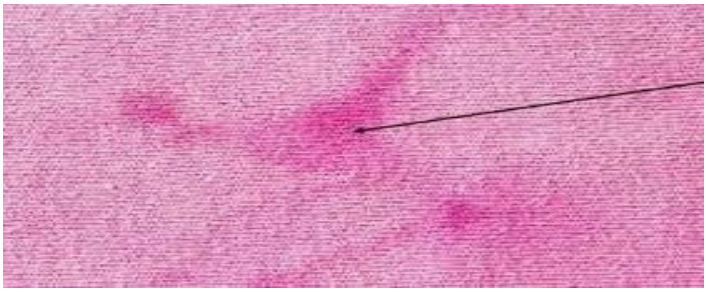


Figure 2. 4: Uneven Dye/printing/Dye Marks

2.1.5 Drop Stitches

Drop stitches, or holes or missed stitches that appear randomly in the fabric, are some of the most frequent quality problems found in raw textiles. Usually, drop stitches result from:

- Improper arrangement of yarn carriers
- Slubs and knots
- Excessive or insufficient feeding of yarn
- Loose stitching throughout the manufacturing process

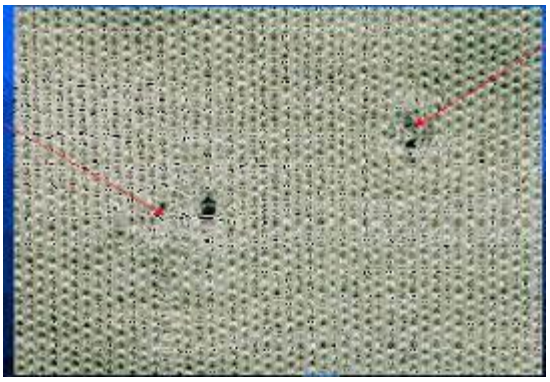


Figure 2. 5: Drop Stitches

2.1.6 Misprinting, off Printing, or Absence of Printing

Only printed fabrics are affected by misprint defects. When the fabric's print deviates from the design you have in mind, it is called a misprint. Typically, this is shown in one of the following ways:

- Partially or absent colors and/or patterns
- The placement of patterns and colors about one another is off.

The most common causes of misprints are:

- Incorrect dyeing recipe
- Incorrect leveling agent
- Inappropriate lot dye combinations

Figure 2. 6: Misprinting, Off Printing or Absence of Printing

2.1.7 Crease Marks

A noticeable distortion in the fabric is called a crease mark. In contrast to a crease streak, a crease mark is less likely to last the length of a roll. Instead, it only makes one appearance on the fabric. A crease mark will remain on the finished item if the final pressing is unable to return the fabric to its original state. This fabric flaw may also lead to issues with discoloration.

Figure 2. 7: Crease Marks

2.1.8 Barre

An inadvertent, recurring visual pattern of uninterrupted bars and stripes is called a barre. Typically, a barre will appear as a fabric-wide, horizontal streak of light or dark bars. To be classified as barre, the bars must repeat themselves. Usually, the barre is located parallel to the filling of circular knit or woven fabric courses. Usually, barre is not discovered until the end of production, following the fabric process

Figure 2. 8: Barre

2.1.9 Nep/Knots

Nep are tiny, disorderly masses of tangled, knot-like fibers that resemble pinheads. Usually, these knots are made of young or dead fibers. Nep can be categorized into three types:

- **Biological:** This nep includes foreign materials in its raw materials, such as pieces of seed coat and leaf or stem material. Usually, the manufacturer can get rid of them by wet processing.

- **Mechanical:** This nep is the outcome of mechanical processing and can be found in cloth, yams, card web, and ginned lint.

- **White speck nep:** Usually invisible until dyeing, white speck nep is thought to be the most severe kind of nep and has immature fiber clusters.

Figure 2. 9: Neps/ Knots

2.1.10 Abrasion Marks

Any discolored area caused by rubbing or friction is called an abrasion mark. Sometimes chafe marks or bruised areas are used to refer to abrasion marks.

Figure 2. 10: Abrasion Marks

2.1.11 Splicing

To ensure continuous spreading, splicing is the overlapping of the cut ends of two pieces of fabric—the end of one length and the beginning of another. When one roll of fabric ends and the next is put to use, splicing becomes necessary. However, during manufacturing, these overlapping ends of fabric generate waste material. Splicing losses may account for as much as 5% of the total amount of fabric used. Importers can reduce the amount of splicing in their fabric to ensure increased manufacturing efficiency. Every splice discovered during fabric inspection carries four penalty points, which are assigned by many importers under the 4-point system.

Figure 2. 11: Splicing

2.1.12 Holes

A hole is an imperfection in which there is an opening in the fabric caused by enough damage to one or more yarns. Depending on their size, holes are usually given two or four penalty points during fabric inspection and are considered a major defect in the fabric.

Figure 2. 12: Holes

2.1.13 Defective Selvedge (Cut, Waved or Creased)

The tightly woven edge of a piece of cloth is called selvage. The selvage, which is most frequently mentioned about woven fabrics, is meant to prevent the material from fraying or unraveling. Selvage may be flawed in several ways, such as being creased, waved, or cut. Selvage that has been cut can also be referred to as ripped or broken selvage.

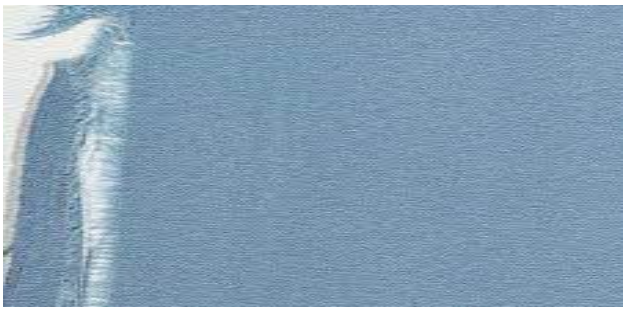


Figure 2. 13: Defective selvage (cut, waved, or creased)

2.1.14 Snags

A snag occurs when a strand of yarn is inadvertently torn or pulled away from the surface. It usually shows up as a big yarn loop that is above the fabric's surface. The snag in warp knits happens in the direction of the wale. The snag in weft knits happens in the direction of the course.

Figure 2.14: Snags

2.1.15 Thick Place/Thin Place

These are inadvertent variations in the fabric's appearance from the nearby construction. In fabric inspection, a thick or thin spot is usually categorized as a major defect if it is wider than one inch. This is because a thick area will manifest as a cluster of thick yarns or as a small area of yarns

that are closer together. On the other hand, a thin area will give the impression of having a collection of thin yarns or loosely spaced yarns.

Figure 2. 15: Thick place/ Thin place

2.2 Defects of Cutting Section

In the apparel industry, waste is an inevitable byproduct of the cutting process. It alludes to the material or leftover cloth that is produced during the cutting process. Several variables, such as the intricacy of the design, the properties of the fabric, the methods used for cutting, and the cutter's expertise, can affect how much is wasted.

2.2.1 Cutting Mistake

Because so little fabric is wasted during the fabric-cutting process, it is the most important step in the production of clothing. The effectiveness of the marker planning for that specific clothing style determines how quickly waste is reduced.

The planning efficiency of 85–90% is regarded as exceptional. Thus, between 10% and 15% of cutting may be wasted. This waste is not available, and in addition, manufacturing errors, poor cutting, excessive overlapping or tailing, long lay lengths, and other factors can all lead to excessive cutting waste. Moreover, ragged edges, fused edges, and poor. While packing and sorting the cut pieces, mistakes like poor-quality notches or drilling may happen, along with other waste.

2.2.2 Panel Checking

This is done to identify the problematic areas of the clothing. The defective parts are rejected first. Following identification, the defective components were weighed and reported as a percentage of the fabric's initial weight. In addition, waste fabric is discovered when panels are checked for flaws in the fabric, a novice cutter, malfunctioning machinery, and cut fabric that is used for various purposes such as shrinkage testing, GSM testing, lab dips, etc. and is obtained from the dyeing and

finishing department. Wastes can occasionally occur as a result of poor embroidery and printing in various clothing components. Additionally, the variation of the aforementioned factors is responsible for the variation of wastes and efficiencies across different days and references.

2.3 Defects of Sewing Section

The act of sewing involves creating stitches with a needle and thread to join two pieces of fabric. One of the fundamental processes in the production of clothing is sewing. Furthermore, the most important sector of the ready-to-wear industry is the sewing sector. Various kinds of errors or flaws occur in the sewing division, which is in charge of waste fabric. In addition, fabric waste in the sewing department is brought on by garment rejection from various stitching errors made by inexperienced operators and broken sewing machines. When two or more layers of fabric, leather, or other materials are sewn together, the process is called seaming. Many seam flaws in clothing were discovered during that time of sewing. In sewing, assembly consists of some sewing defects:
Needle damage can take the form of a big hole in the fabric or thread being pulled out of it.

- A stitch omitted.
- Abrasive thread.
- Piping at the seams.
- The incorrect stitch density.
- An uneven seam.
- Stitched unevenly.
- A damaged seam.
- A stain or oil spot.

Some Seaming Defects are:

- Unequal breadth.
- Uneven stitching.
- Not bound with a backstitch.
- Bending.
- No check or stripe matching.
- Not matching the edges.
- The sewing has unexpected materials attached to it.
- Not sewn with the matching fabric on the front or back.
- Incorrect type of stitch is used.
- Incorrect matching of the sewing thread shade.

Some Assembly Defects are:

- Finished components that are flawed due to their size, meaning they have irregular dimensions and shapes.
- Incorrect size for the clothing.
- Using the incorrect ticket.
- Missing any components or the clothes' predefined design.
- Inaccurate placement of components such as buttons, hooks, and so on
- Incorrect interlining placement or creasing.
- Interlining's tightness or looseness.
- Folding any clothing components that give the impression of being poorly made.
- Variation in clothing shade.
- The incorrect orientation of the clothing's fabric components.
- Incorrect fit between the garments' trimmings.

2.4 Defects in the Finishing Section

Through a variety of procedures and treatments, the finishing sector of the textile industry may be a contributing factor in the production of waste. The following are some factors concerning textile waste in the finishing section:

1. Chemical Waste: Chemicals including dyes, pigments, coatings, and treatment agents are used in a few finishing processes. When these chemicals are handled or disposed of improperly, pollution and environmental harm may result. Aquatic ecosystems may be at risk from chemicals that are improperly absorbed or treated and wind up in wastewater. To reduce chemical waste, textile manufacturers must adhere to regulations and good waste management practices.

2. Overuse of Chemicals: Overuse of chemicals during the finishing process may occasionally lead to waste. Fabrics that have been overdyed or overtreated may produce excess and unused chemicals that are eventually thrown away, adding to waste and negative environmental effects.

3. Water Waste: Water is needed for several finishing procedures, including washing, treating, and rinsing fabrics. Water waste can result from overusing water or poor water management techniques. Reusing, recycling, and treating water properly can help cut down on water use and its negative effects on the environment.

4. Fabric Scraps and Trimmings: Cutting and trimming fabric to the correct size or shape is a common finishing step. If not handled appropriately, these trimmings and scraps of fabric may turn into waste. Reducing their impact can be achieved by putting upcycling or recycling programs to reuse or recycle these waste textile materials.

5. Packaging Waste: When shipped and distributed, finished textile products are frequently packaged. Packaging supplies like cardboard boxes, plastic wrap, and other packing elements can increase the amount of waste produced. Recyclable and environmentally friendly packaging materials can reduce this kind of waste.

Finding the rejected clothing helped to expose the waste in the finishing section. Next, the fabric weight was calculated using the fabric consumption formula. Furthermore, mishandled garment manufacturing guidelines lead to a variety of faults, heavy spots, ironing and measuring issues, and other wastages in the finishing section. Once more, as mentioned in the last section, lot rejection results from a decrease in lot size relative to order size. The last phase of manufacturing is finishing.

2.5 Review of Recent Research Work

Pingki, M.J. (2019) has elaborated **that** the process of creating clothing patterns with little to no fabric waste is known as "zero waste design" or "zero waste pattern making." This is accomplished by using meticulous pattern layouts and inventive ways to get rid of strange curves that leave too-small scraps on the cutting room floor. To create the "perfect" zero-waste clothing, designers are adopting the term, which is purposefully ambiguous, and a variety of methods, materials, and technologies are being used. Today's fashion designers who are committed to sustainable fashion have been incorporating the zero-waste approach into their designs. It is acceptable to include zero-waste fashion in the movement toward sustainable fashion. **Ali, Md.Y. (2022)** provided detailed in the goal of this research is to increase marker efficiency and decrease fabric consumption. Fabric waste during cutting is decreased thanks to advancements made to the current markers. Techniques: In the current study, a pattern and marker were created using the Gerber CAD/CAM software version AccuMark 8.5.1. This experiment is carried out using a noble method and Gerber CAD/CAM software. Simple markers are made at the beginning and are later replaced by real markers on the market based on developed specimen allowance. The overall efficiency has increased to 9.25% and wastes have decreased**.**

Naveed, T., Hussain, A. and Zhong, Y. (2017) compared to the other materials used in the production of clothing, the fabric accounts for more than half of the total cost. Making effective use of fabric can save a significant amount of money and effort. To enhance fabric utilization and visual quality control, the goal of this study is to propose an image-projected virtual marker (IPVM) onto the surface of fabric layers or plies. Twenty orders for clothing production are planned as part of the experimental work to look into using fabrics that have flaws. The statistical analysis shows improvements in fabric utilization of 3.5%–4%, visual inspection throughput time of 22%, and labor intensity of 25% during visual inspection in the cutting room. The outcome suggests that the suggested strategy is a successful means of increasing fabric utilization and lowering costs**. M. Janarthanan, R.T. Nithinmanighanden, Muralidharan, Prasanth. (2020)** elaborated the ready-to-wear industry is one of the main drivers of the textile sector's growth, and as such, productivity and quality are essential to the nation's economic progress. This report provides a detailed analysis of how to use

Industrial Engineering techniques to reduce fabric waste by increasing fabric utilization in a garment factory. This study aims to reduce waste to enhance fabric utilization. The guidelines for improving and controlling waste in the clothing industry are provided in this work, which can be spread and cut using innovative techniques.

R. Rathina Moorthy. (2018) said that the goal of this research is to recycle waste fabric into fibers. The primary goal is to create new clothing products using recycled yarn, fabrics, and fibers. The cutting waste from the industries that produce knitted garments was gathered and used in the recycling process for this reason. The fabrics' physical attributes, such as dimensional stability, bursting strength, pilling, and abrasion resistance, were found to be acceptable. The materials were used to create casual clothing, and a cost-effectiveness analysis was done on the final products. The findings were encouraging in that clothing made from recycled fibers can be produced for less money than clothing made from regular raw materials. Additionally, it benefits manufacturers in two ways: it solves waste management and allows them to make some money off of the waste and resolves problems with disposal and waste management as well.

Walaa Alsamarah Basel Younes Maged Yousef, (2021) has conducted this paper to review the production orders in the cut department of the company under study to improve the process of determining the optimal distribution of higher investment in raw materials by utilizing artificial intelligence algorithms. For every executed order, the waste rate, the number of layers, and the number of markers were examined and evaluated. The study's methodology is covered under Genetic Algorithms, which are programs that are created by expressing a problem through code after a high-level analysis of the problem. The new scheduling method is a powerful optimization technique that reduces the percentage of fabric waste by 2.62% when compared to the original process. It also minimizes the number of spreading layers by optimizing the cutting table from 56 to 25 layers and lowering the number of markers from six to three. The technique acquired could be used in the cutting division and offer additional expertise in operating and maintaining the manufacturing system.

2.6 Literature Gap

Garment wastage is identified in many sources. But the specific amount of wastage wouldn't be reduced. The development of standardized techniques for measuring fabric waste at various supply chain stages, from manufacturing to consumer use, could be the subject of future research. Investigating how cutting-edge technologies like on-demand manufacturing and 3D knitting might help minimize the amount of fabric wasted during production. Looking into the possibilities and difficulties of introducing creative and sustainable production techniques in the textile sector. Examining the viability and effects of circular economy ideas in the textile sector, including methods for repurposing and recycling waste fabric. Assessing the success of current laws and business campaigns to cut down on wasteful fabric use.

Garment wastage is identified in many sources. But the specific amount of wastage wouldn't be reduced.

CHAPTER THREE
RESEARCH DESIGN

3.1 Methodology

Study and Research

- A thorough investigation into the extent of clothing waste in the fashion business should be carried out.
- Examine the effects of clothing waste on the economy, society, and environment.

Establish Goals and Objectives

- Goals for controlling the waste of clothing that are in line with sustainability ideas.
- Establish clear goals for measuring your progress, like lowering carbon emissions, water, and energy use, and textile waste.

Create and Put into Action Sustainable Practices

- Encourage the application of eco-friendly materials, effective production methods, and timeless, long-lasting design concepts.
- Promote ethical supply chains and responsible sourcing, which includes the use of recycled or organic materials.
- Put waste reduction techniques into practice, like cutting down on offcuts, recycling fabric remnants, and streamlining production procedures.
- Encourage the implementation of circular economy strategies, such as recycling campaigns, services for clothing repair and alteration, and secondhand marketplaces.

Knowledge and Insight

- Run educational initiatives to inform the public about the negative effects of clothing waste and the significance of choosing sustainable fashion options.
- Give retailers and manufacturers information and instructions on waste reduction tactics and sustainable practices.

- Work with academic institutions to include courses on sustainability in fashion and textile design.

Cooperation and Joint Ventures

- Encourage industry stakeholders to work together to share best practices and promote group action, such as manufacturers, retailers, NGOs, and legislators.
- Interact with authorities to push for policy modifications that encourage waste minimization and environmentally friendly methods in the fashion sector.

Observation and Assessment

- Create monitoring systems, including data collection on waste generation, resource consumption, and emissions, to track progress towards the established targets. B. Perform routine audits and assessments to gauge how well-implemented practices are working.
- Gather information through stakeholder consultations and feedback mechanisms to modify the approach as needed.

Reporting and Openness

- Create frequent reports outlining the status, triumphs, and difficulties surrounding the management of clothing waste.
- To foster trust with stakeholders, place a strong emphasis on transparency when revealing practices, objectives, and results.

3.2 Method Involve in the Research

- **Selection of the factory**: After gathering information we chose a factory near Gazipur.
- **Gathering information**: This step involved gathering data on the portion of the fabric wastages in the garment production process.
- **Finding the problem:** After gathering data in the cutting section, sewing section, washing section, finishing section, and final inspection section, we found the sources of wastage.
- **Data collection and Result analysis:** After collecting data, we calculated data to generate the desired outcome.

3.3 Data Calculation

Through adherence to this methodology, industry participants in the fashion sector can collaborate to minimize clothing waste, advance sustainable methodologies, and establish a more ecologically and socially conscious industry.

To find different types of fabric waste we have visited some garments industry. We have found different types of ready-made garments in this factory. Mainly we have calculated the percentage of wastage in every section – cutting section, sewing section, finishing section, washing section, and finishing section. Different types of ready-made garments are prepared in these factories. Among which we have selected. For data calculation we need the Buyer's name, the Buyer's order quantity, the Total amount of fabric, and how much fabric as input is given in the cutting section. We also calculated the total leftover, excess, or shortfall in fabric. Finally, we have calculated the total amount of waste in fabric and their percentage (%).

The wastage of cutting (%) is calculated by

Wastage in Cutting (%) = (Cutting Input- Cutting Output) *100/Cutting Input

Here cutting output is used as the sewing input. After the sewing process, output data is collected from the sewing section, and wastage in sewing (%) is calculated by,

Wastage in Sewing (%) = (Sewing Input- Sewing Output) *100/Sewing Input

Sewing output is used as washing input and wastage in washing (%) is calculated by,

Wastage in Washing = (Washing Input- Washing Output) *100/Washing Input

The output of the washing section is used as the input of the finishing section. In the finishing section some wastage was also generated After collecting output data that came from the finishing section, wastage in the finishing section (%) is calculated by

Wastage in finishing (%) = (Finishing Input- Finishing Output) *100/Finishing Input

Then the Output of the finishing section is used as the final inspection input and the wastage of the final inspection is calculated by

Wastage in Final Inspection (%) = (Final Inspection Input- Final Inspection Output) *100/Final Inspection Input

After final inspection final packaging is required. Here some excess or shortfall products remain. We have calculated the excess or shortfall in pieces (%).

Excess or Shortfall in Pieces (%) = (Excess or Shortfall*100)/Final Inspection Output

Two garment data were collected and calculated data were shown in the two tables. The identified processes of garment wastage were the cutting section, sewing section, washing section, finishing section, and final inspection. In the cutting section, fabrics are wasted highly.

Table 3.1: Details Information about Fabric Waste in Factory A

01	Factory Name	Factory A		
02	Buyer Name	Zara	Mango	Zara
03	Item Name	Soliel Skirt	Basic Skirt	Girl's Top
04	Order Quantity (Pieces)	18000	32000	25000
05	Quantity with 5% Extra	18900	33600	26250
06	Calculated Fabric Requirements(yards)	18900	11100	52840
07	Calculated Waste Taken (%)	5%	5%	5%
08	Fabric Input to Cutting (Yards)	18850	11020	52500
09	Cutting Output (Pieces)	18620	33250	25910
10	Wastage in Cutting (%)	1.22	0.43	1.26
11	Sewing Input (Pieces)	18620	33250	25910
12	Sewing Output (Pieces)	18480	32910	25780
13	Wastage in Sewing (%)	0.75	1.02	0.52
14	Washing Input (Pieces)	18480	32010	25780
15	Washing Output (Pieces)	18310	32590	25620
16	Wastage in Washing (%)	0.92	0.97	0.60

17	Finishing Input (Pieces)	18310	32590	25620
18	Finishing Output (Pieces)	18200	32395	25440
19	Wastage in Finishing (%)	0.60	0.59	0.72
20	Final Inspection Input (Pieces)	18200	32395	25440
21	Final Inspection Output (Pieces)	18080	32150	25210
22	Wastage in Final Inspection (%)	0.65	0.75	0.52
23	Final Packing (Pieces)	18000	32000	25000
24	Excess/Shortfall (Pieces)	80	150	210
25	Excess/Shortfall in Pieces (%)	0.45	0.47	0.83

Table 3.2: Details Information about Fabric Waste in Factory B

01	Factory Name	Factory B	
02	Buyer Name	Lee	Mango
03	Item Name	Long Shirt	Long Pant
04	Order Quantity (Pieces)	12000	16000
05	Quantity with 5% Extra	12600	16800
06	Calculated Fabric Requirements(yards)	25200	42000
07	Calculated Waste Taken (%)	5%	5%
08	Fabric Input to Cutting (Yards)	25092	41675
09	Cutting Output (Pieces)	12286	16250
10	Wastage in Cutting (%)	2.07	2.52
11	Sewing Input (Pieces)	12286	16250
12	Sewing Output (Pieces)	12192	16200
13	Wastage in Sewing (%)	0.77	0.30
14	Washing Input (Pieces)	12922	16200
15	Washing Output (Pieces)	12146	16145
16	Wastage in Washing (%)	0.38	0.34
17	Finishing Input (Pieces)	12146	16145
18	Finishing Output (Pieces)	12118	16105
19	Wastage in Finishing (%)	0.23	0.25
20	Final Inspection Input (Pieces)	12118	16105
21	Final Inspection Output (Pieces)	12084	16076
22	Wastage in Final Inspection (%)	0.28	0.18
23	Final Packing (Pieces)	12000	16000
24	Excess/Shortfall (Pieces)	84	76
25	Excess/Shortfall in Pieces (%)	0.70	0.47

Table 3.3 Quantity of Waste for Soliel Skirt in Factory A

Section	Quantity of Wastage (pcs)	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting		230	1.22%
Sewing	140	140	0.75%
Washing	170	170	0.92%
Finishing	110	110	0.60%
Final Inspection	120	120	0.65%
Total leftover	80	80	0.44%
Total	620	850	4.58

Table 3.3 tells us that an order quantity of 18,000 pieces was required to make a Soliel skirt. 18850 yards of fabric were removed. 230 yards (1.22%) of fabric were wasted in the cutting section. 140 yards (0.75%) of fabric were wasted in the sewing section. In the washing section, 170 yards (0.92%) of the total fabric were wasted. There were 110 yards (0.60%) of wasted fabric in the finishing area. During the final inspection, 120 yards (0.65%) of fabric were wasted. Next Following the last packing, 80 pieces remained, resulting in 80 yards (0.44%) of waste fabric.

Table 3.4 Quantity of Waste for Basic Skirt in Factory A

Section	Quantity of Wastage (pcs)	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting		47.5	0.43
Sewing	340	112.2	1.02
Washing	320	105	0.97
Finishing	195	64.35	0.59
Final Inspection	245	80.85	0.75
Total leftover	150	49.5	0.46
Total	1250	459.4	4.22

From table 3.4, we have found that to produce a Basic skirt the order quantity was 32000 pcs. 11020 yards of fabric were taken. In the cutting section, 47.5 yards (0.43%) of fabric were wasted. In the sewing section, 112.2 yards (1.02%) of fabric were wasted. 105 yards of total fabric (0.97%) were wasted in the washing section. In the finishing section, 64.35 yards (0.59%) of fabric were wasted.80.85 yards (0.75%) of fabric were wasted in the final inspection. Then After final packing 150 pcs were leftover that occurred 49.5 yards (0.46%) of fabric waste.

Table 3.5 Quantity of Waste for Girl's Top in Factory A

Section	Quantity of Wastage (pcs)	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting		630	1.26
Sewing	130	260	0.52
Washing	160	320	0.60
Finishing	180	360	0.72
Final Inspection	230	460	0.92
Total leftover	210	420	0.84
Total	910	2450	4.86

From table 3.5, we have found that to produce a Girl's Top the order quantity was 25000 pcs. 52450 yards of fabric were taken. In the cutting section, 630 yards (1.26%) of fabric were wasted. In the sewing section, 260 yards (0.52%) of fabric were wasted. 320 yards of total fabric (0.60%) were wasted in the washing section. 360 yards (0.72%) of fabric were wasted in the finishing section.460 yards (0.92%) of fabric were wasted in the final inspection. Then After final packing 210 pcs were leftover that occurred 420 yards (0.84%) of fabric waste.

Table 3.6 Quantity of Waste for Long Shirt in Factory B

Section	Quantity of Wastage (pcs)	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting	260	520	2.06
Sewing	94	188	0.74
Washing	46	92	0.36
Finishing	28	56	0.22
Final Inspection	34	68	0.34
Total leftover	84	168	0.66
Total	546	1092	4.34

From table 3.6, we have found that to produce a Long Shirt the order quantity was 12000 pcs. 25092 yards of fabric were taken. In the cutting section, 520 yards (2.06%) of fabric were wasted. In the sewing section, 188 yards (0.74%) of fabric were wasted. 92 yards of total fabric (0.36%) were wasted in the washing section. In the finishing section, 56 yards (0.22%) of fabric were wasted.68 yards (0.34%) of fabric were wasted in the final inspection. Then After final packing 84 pcs were leftover that occurred 168 yards (0.66%) of fabric waste.

Table 3.7 Quantity of Waste for Long Pant in Factory B

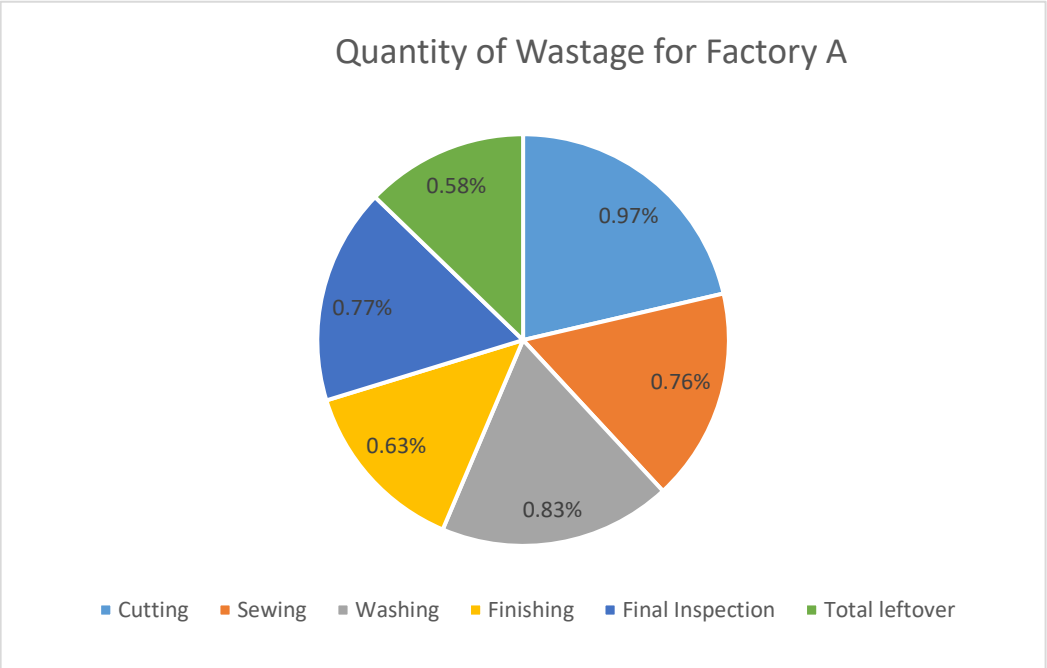
Section	Quantity of Wastage (pcs)	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting	260	1050	2.52
Sewing	94	125	0.30
Washing	46	137.5	0.33
Finishing	28	100	0.24
Final Inspection	34	72.5	0.17
Total leftover	76	190	0.46
Total	546	1675	4.02

Table 3.7 shows that a 16,000-piece order was required to manufacture Long Pants. There were 41675 yards of fabric taken. 1050 yards (or 2.52%) of fabric were wasted during the cutting process. A total of 125 yards (0.30%) of fabric were wasted in the sewing stage. In the washing portion, 137.5 yards (0.33%) of the total garment were wasted. There were 100 yards (0.24%) of wasted fabric in the finishing section. During the final inspection, 72.5 yards (0.17%) of fabric were wasted thrown. Next Following final packing, 76 pieces remained, amounting to 190 yards (0.46%) of waste fabric.

CHAPTER FOUR

RESULT AND DISCUSSION

Table 4.1 Average Quantity of Waste for Factory A



Section	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting	30.25	0.97%
Sewing	171	0.76%
Washing	198	0.83%
Finishing	178	0.63%
Final Inspection	220.28	0.77%
Total leftover	183.16	0.58%

Figure 4.1: Quantity of Wastage for Factory A

Here is our measured data for factory A, total fabric waste for Soliel Skirt, Basic Skirt, and Girls Top. The quantity of total waste for factory A is 0.97% for the Cutting Section, 0.76% for the Sewing Section, 0.83% for the Washing Section, 0.63% for the Finishing Section, 0.77% for the Final Inspection, and 0.58% for the Total Leftover. In the Cutting Section fabric is wasted highly for Factory A.

Table 4.2 Average Quantity of Waste for Factory B

Section	Quantity of Wastage (yards)	Quantity of Wastage (percentage)
Cutting	785	1.66%
Sewing	156	0.63%
Washing	115	0.96%
Finishing	70.25	0.47%
Final Inspection	264	0.63%
Total leftover	294	0.75%

Figure 4.2: Quantity of Wastage for Factory B

Here is our measured data for factory B, total fabric waste for Long Shirts and Long Pants. The quantity of total waste for factory B is 1.66% for the Cutting Section, 0.63% for the Sewing Section, 0.96% for the Washing Section, 0.47% for the Finishing Section, 0.63% for Final Inspection, 0.75% for the Total Leftover. In the Cutting Section fabric is wasted highly for Factory B.

4.1 Discussion

For wastage calculation, it has been measured two garment factory's data. Fabric is wasted in the Cutting Section, Sewing Section, Washing Section, Finishing Section, and Final Inspection in a Specific amount. In the Cutting and Sewing section, fabric is wasted highly. First and foremost, a developed CAD section is needed to reduce the wastage of the Cutting Section. additionally require a digital cutting machine. Sewing waste is a major source of generated waste in the apparel industry. To minimize the overall waste of the garment business, it is necessary to reduce the waste that results from sewing. The most common reasons for sewing waste involve sewing defects such as uneven joints, double stitches, oil stains, holes, and broken stitches. The first step in minimizing sewing waste is to have a highly skilled operator and a computerized sewing machine. A stronger sewing quality section is required to detect sewing flaws at the right moment. Finally, waste for the Finishing and Final Inspection Sections can be decreased with the help of an automatic defect identification system, a digital machine, and a skilled operator.

CHAPTER FIVE
CONCLUSION

At last, we have completed our thesis after a long time and lots of inspection, and discussion. This study is an experimental examination aimed at determining the origins of fabric waste in the ready-made garment sector. Wastage mainly occurred in the cutting section, sewing section, washing section, finishing, and final inspection section. We have researched precisely how much is wasted in this process. After collecting every section of data, a considerable amount of waste was produced by each one.

After collecting we find that the main source of fabric waste is the cutting portion. In comparison to other sections, this amount is relatively higher in the garment industry. We have also found that some waste is produced by other sections as well. In the sewing section and cutting sections, there are less amount of wastage was found. Although the amount of waste generated in the other portion is less than that in the cutting section, it still affects the overall amount of fabric waste. Once everything was packed up, there were a lot of additional pieces that were left over as leftover products. These were also considered waste and were later sold at the local market or given to buyers if they agreed, but we also considered leftover items as waste.

5.1 Recommendations for Further Research

- By gathering accurate information and data more widely the result can be more effective in the ready-made garments industry.
- By learning more about the washing process to find out how to reduce the term washing wastage.
- By evaluating this data, more effective techniques can be implemented to reduce fabric wastage in the garment industry.

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