

REVIEW

The Basic Layout of a Denim Textile Industry: A Basic Review

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ABSTRACT

Denim was produced in the city of Nîmes in France and was originally called the serge de Nîmes. The word denim is an English colloquialism of the French term: "denim." Day by day Bangladesh denim sector very much developed and helps to increase productivity. Bangladesh have seen a significant increase in investing in denim fabric manufacturing, increasing the country's production performance by reducing fabric dependence on imports. It is important due to its aspects of durability, and not easily torn which benefited physical laborers much. The government also plays a vital role in denim textile industry. This paper shows different section of denim textile industry such as: sewing section, cutting section, washing, IE and finishing department. The main aim of this paper is how to role all the section of denim textile industry. Textile education is insufficient without industry attachment, which bridges the gap between theoretical and practical aspects and acclimates students to the industrial world. We can gain about theoretical development on an industrial level from this attachment. We can understand more about the machines used in various departments, their technical specifications, characteristics, operating system, and so on, and we believe that without this type of industrial connection, it is impossible to obtain industry-based information about textile engineering adequately. The Industrial Attachment on Denim Manufacturing Technology was used to organize this study (sewing section, cutting, IE, washing section, CAD Section, and finishing department. Various operating procedures for the production of denim in the industry are presented in this paper. The technique and process of several procedures and processes are presented here such as machine specifications, manpower, maintenance, layout of the different section, dye processes and wet processes.

1. Introduction

By exporting these products, the textile and garment industry contributes significantly to Bangladesh's economic development. From 1972 to 2019, Bangladesh's gross do-

mestic product (GDP) expanded from \$6.29 billion to \$286 billion, with \$41 billion originating from exports, with a startling 84 percent coming from textile and garment exports^[1]. Denim garments are one of the most important components of Bangladesh's textile industry. Denim garments are a fam-

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ily-friendly outfit that may be worn by people of all ages and have evolved into textile and apparel products^[2]. Bangladesh is a textile industry-based country. Denim garments (trousers) are being produced with other garments to meet its demand in the competitive market of world and Bangladesh earned about 76% foreign currency from ready-made garments sector^[3]. The Bangladesh denim industry is currently the top producer of denim in the European Union and United State markets. The denim industry is slated to go past 64 billion Dollar by 2020. By 2021, apparel manufacturers in Bangladesh will be exporting more than 7 billion Dollar worth of denim to traditional and non-traditional markets combined^[4]. Two years back, Bangladesh was highly dependent on imported denim fabrics, but now Bangladesh can meet about 50% of the demand locally and are also exporting to some of the globally renowned buyers. In fine, Bangladesh has an enormous opportunity to grow in the RMG export markets as denim products have emerged as major players in the global markets. In this regard, Bangladesh government should prioritize denim products and provide all-out support to the entrepreneurs^[5]. Denim garments are made from denim fabrics, which are one of the world's oldest fabric kinds and may always seem new thanks to years of intensive product development. There are a huge number of denim company remained in Bangladesh. One of them "Shasha Denims Limited" most significant in Bangladesh^[6]. This company plays the most important role in denim sectors in Bangladesh. One of the most growing up Denim Garments in Bangladesh. The "Shasha Denims Limited" company has earned a reputation throughout the global woven industry as one of the foremost factories in Bangladesh for their commitment to quality, timely delivery and total value. This company is located at Savar, Dhaka-Bangladesh. The present chairman of this company is Mr. Anisul Islam Mahmud and managing director Mr. Shams Mahmud. The present address of this company is Plot: 184-193 & 277, DEPZ (Ext.) BD- Savar, Dhaka, Bangladesh. In 1991, this company was established, and the factory area is 25000 square fits. The most important factor of any factory is it's workpeople. Most of the development of a company depends on it's workpeople or labor or worker. We have investigated that more than 4,000 workers are working here. In this paper we discuss a principle layout of a denim industry of Bangladesh.

2. Methodology

In this review paper, all data and information are collected from secondary sources including previous articles, research papers and newspapers. Besides, mathematical calculations are collected from "Aaron Denim", a denim industry in Savar-Dhaka.

3. Different Departments

Departmental investigation was the focus of our investigation. Each and every company has it's own departmental section. Departmental section is also the most important things that categorized a company according to the company's rules and regulations. There are various departments in a denim industry which are discussed in the following sub-sections.

3.1 Store and Inventory

The stock of any item or resource utilized in a process is referred to as inventory^[7]. Fabric inventory contains a variety of fabrics and accessories, such as sewing thread, needles, interlining, zippers, labels, and other items. Keeping a well-organized and well-equipped fabric inventory system is important for bulk productions in the clothing business. The following is a flow chart of the Fabric Inventory Management system in the denim textile Industry^[8].

3.2 Sample Section

One of the most significant stages in the denim textile industry is sampling. Samples are a method to attract a buyer and confirming a purchase. Several types of samples are generated and submitted to the buyer for approval^[9]. The ability of exporters to deal with every given style of garment is evaluated by samples. The buyer analyses the samples for style, construction, fit, or quality, among other criteria. Every factory has its own sampling department, whose duty it is to create various samples and obtain approvals for them. The sampling department produces samples based on the buyer's requirements and specifications. Spite of the fact of sampling is tough and time-consuming, it will help the exporter.

3.3 Cutting Section

Fabric cutting is the process of dividing out pattern parts of garment elements from a fabric lay as per pattern's specified specifications^[11]. It's not like common cutting, where the actual dimensions aren't taken into account. The cutting process is the first step in the manufacturing of clothing. Fabric is cut into components (various shapes or patterns) in this procedure. Front, back, sleeve, and collar forms, for example). Multiple layers of fabrics are spread out on a table in mass production, and large amounts of fabric are used. At any given time, the certain quantity of garments are being cut. The term "lay" relates to the fabric stack that has been set out.

Several Actions in Cutting Section

There are different types of action needed in the cutting section. All are important in denim textile industry when

Table 1. Objective of different types of sample ^[10]

Serial no.	Type of sample	Objective
1	Proto Sample	To examine the garments design and style of the garment.
2	Fit sample	To ensuring that the garment fits properly.
3	Salesman sample	To show at numerous showrooms to obtain customers.
4	GPT sample	To see how far the clothing functions in various physical and chemical.
5	Size set sample	To assess the factory's ability to produce samples of different sizes.
6	Pre-production sample	To prepare a standard sample for mass production.
7	Pilot run Sample	To inform the buyer about the factory's realistic bulk industrial capacity.
8	Top sample	To convince the buyer that the same quality is maintained as in the sample.
9	Shipment Sample	To satisfy the purchaser that the quality of the product will be maintained to until termination of production.

we take this kind of action we increased our production ^[12]. All these actions shown in this paper:

Purchase fabric from the fabric store

The production manager provides the cutting department a cut order. The cutting in-charge develops a fabric requirement sheet or requisition slip for the fabric store to issue fabrics according on the cutting plan.

Relaxation of fabrics

Knitted fabrics require relaxation before cutting. After receiving the fabric from the fabric store, the cutting department opens the fabric from the fabric roll and lays it on the table for relaxation for some hours before cutting. Factories also relax fabric in the fabric store overnight after opening the fabric rolls.

Cut order planning

The cutting master plans the number of markers they need to prepare, the size combination to be set for each marker and the number of plies to be laid in each marker.

Cloth spreading/layering

Multiple layers of fabric are cut at the same time in mass production. As a conclusion, spreaders arrange the fabric on a cutting table in agreement with the total marker length. The layer height is restricted with one inch.

Planning marker

The cutting master plans marker ways, marker lengths and the numbers of plies to be laid in each lay.

Making marker

This is the process of sketching out garment patterns on the lay in preparation for cutting the garment components. The marker paper and placed on top of the layer after it has been laminated. Those companies without CAD

markers make them by manually with paper patterns.

Fabric cutting

Following the formation of the marker, apparel patterns are cut and eliminated from the layer. Fabric layers are cut using a wide range of technologies, namely straight knife cutting, band knife machine cutting, and a computer-controlled automatic cutting machine.

Sorting, bundling, and numbering of garment plies (parts)

Layers are classified by size and colour after cutting the fabric. Stickers are being used to number each layer. Before being transferred to the next phase, bundles are stored on inventory tables.

Assessment of cut components

To maintain cutting quality, quality testers inspect standard cutting components at random. If any faulty components are identified, they are repaired. Its looks into the specifics of cut part inspection.

Sorting printed and embroidery panels

Printing and embroidery were done on cut panels as according to order requirements. After receiving printed and embroidered panels, size sorting is performed. The cutting section regularly double-checks printed and embellished panels.

Re-cutting panels

For garment components that need to be replaced in bundles, re-cutting is done. The sewing department gives out re-cutting requests for faulty garment parts. Block panels cut for the printing and embroidery operations are also re-cut. These panels are reshaped after receiving them from the printer or embroiderer.

Fusing garments component

Fusing in garment components is done to stiffen parts of a garment. If needed, fusing is done at the cutting section (e.g., fusing of the collar and cuff components of formal shirts).

3.4 Sewing Section

Sewing is considered as the heart of a garment in the fashion market^[13]. After receiving all of the garment parts from the define phase, the parts are sewn together using a sewing machine. Sewing Section is a very important department in the denim textile industry because it allows the maker to obtain a complete aspect of the garments. This paper talks about the most important element of denim sewing section inspection.

3.4.1 Inspection of the Sewing Section

We need to identify a few basic needs that are vital in the denim sewing part for a smooth and perfect sewing operations^[14]. In general, there are three phases to inspecting the manufacturing part of clothes. They are discussed in the following sub-sections.

3.4.2 Sewing Inspection

No needle holes should be seen. Only defective stitches, such as slipped stitches, staggered sewing, and asymmetrical stitches, should be visible. It's better to avoid puckering at the seams.

The density of the stitches should be comparable. Uneven stitch length should be minimized. A spot of oil or an uneven stitch length should be inspected.

3.4.3 Seaming Inspection

Unequal width of seam. Insecure seam. Miss matching of stripe and checks between two components along seam line. Trapping of foreign materials inside the seam. When the fabric's front and back sides aren't the same. Application of the improper stitch type or seam type.

Variation in shade between stitches.

3.4.4 Assembling Inspection

Any component that is the wrong size or shape. The clothing were the correct length. Any design in clothes is ignored. Any component in a garment that is not properly situated. Incorrect interlining placement and fusing. Variation in shade from one component to the next.

3.5 Denim Washing

In the denim sector, the garment was a new tech-

nique^[15]. Normally, the term "washing" means the act of cleansing something. However, in the denim industry, simply cleaning clothing is not considered a garment wash. Denim washing is a technique for adjusting the appearance, comfort, and design of garments^[16]. Solid coloured clothing and solid printed fabric are subjected to denim washing. Nowadays many types and objects of wash used in the denim textile industry.

3.5.1 Denim Washing Objectives

There are many washing objectives in denim textile industry. All are necessary for developed and increased the productions. All are included in this paper such as: To remove filth, dust, and waste from clothes, To remove size materials from garments, For garments wash shrinkage occurs, so accurate measurement can be found by customers, Fading effect is varied here by variation of an amount of detergent used, processing time and processing temperature, To increase the brightness of garments, To increase the smoothness of garments, To change the appearance of garments, To make directly wearable after purchase, To make garments become soft and handy and To remove harmful materials from garments^[17].

3.5.2 Process Flow Chart of Denim Garments Washing

Denim is essential part of garments. Garments washing has some processes. All the processes are important for denim textile industry^[18]. When washing is not good then we can't good products. Actual process flow chart for garments washing are mentioned in the following:

3.6 Administration

As companies increasingly sell services and look for opportunities beyond their home markets, their supply chains become more global^[19]. Product design, for example, traditionally heavily global inputs, and products are sold around the world. Because of lower labour or material costs in other countries, some manufacturing operations or services may be outsourced. In this section, the current state of the textile industry in various nations has been demonstrated, including Pakistan, India, Vietnam, Taiwan, Thailand, China, and Bangladesh. It is important of our denim sector.

Management System of a Denim Industry

Each garment is run by a management committee. The managing director is responsible of that committee, and many executives in various positions assist him. The higher are listed below in order of power and function.

Table 2. Schematic flow chart of denim washing

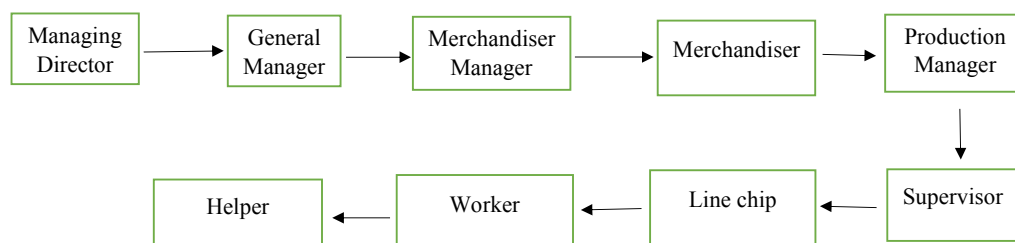
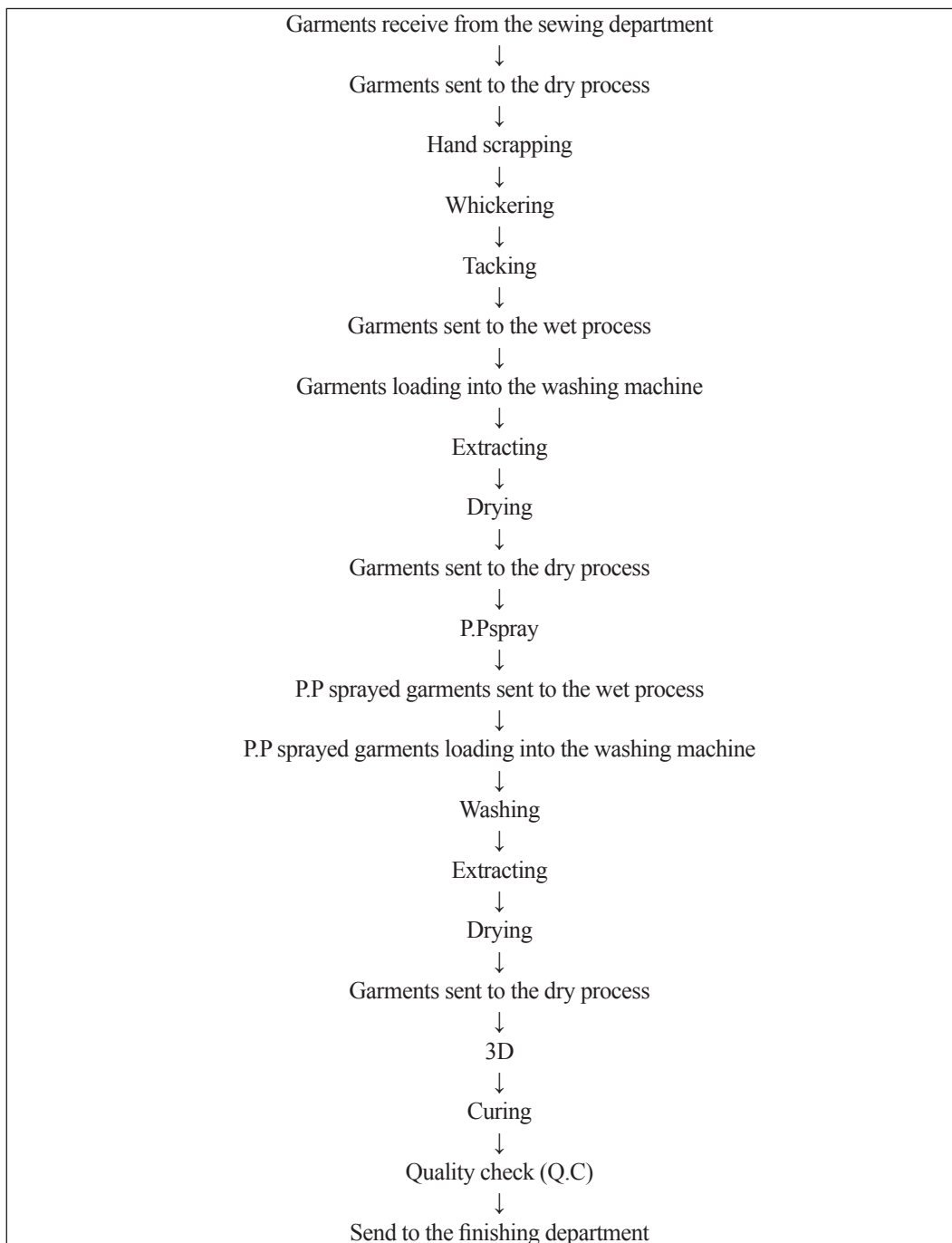


Figure 1. Management system of a denim industry

3.7 CAD Section

Because the denim textile industry is the most skilled labour-dependent industry, any cost savings through new Computer-Aided Design (CAD) technologies has become a requirement in gaining a competitive advantage, most universities have included CAD pattern making systems education and training as part of their clothing technology courses in recent years, in response to the actual needs of the fashion world for high-skilled fashion designers and clothing engineer^[19]. CAD/CAM (Computer Aided Manufacture) systems enable a design to be created and altered fast without sacrificing creativity, and they improve communication and integration across product development systems. They've played a key role in reducing the cycle time, increasing accuracy, and placing clothes products in stores significantly closer to when customers need them.

With the increasing application of open-source software (OSS) in a various application, it's essential to determine whether existing OSS CAD software for garment prototype development can support the learning process. An objective assessment of CAD model complexity, per the summers and Shah can be useful in assessing case studies, evaluating the results of experiments, or evaluating student projects. The probable impacts of CAD model complexity have been recognized by a number of other publications. Modelling technique, according to Johnson, Valverde, and Thomison, comprises the amount of time spent on particular learning activities. In total, two licensed and two OSS systems were compared for their usefulness in producing ten different pattern designs for garments. The results of a day when evaluation of a collection of computer systems and licensed CAD systems are provided and critically evaluated.

Purposes of CAD in Denim Industry

Textile engineering (TE) and fashion technology (FT) educational and training are constantly subjected to official evaluation by various certification agencies. Traditional CAD and drawing courses mainly focus on geometric modeling, including wireframe, surface, and solid modeling. According to Ullah and Harib, the material of a CAD/CAM course should help students achieve at least the following four outcomes:

- a. The ability to apply math, science, and engineering knowledge.
- b. The ability to design a system, component, or process that meets the desired needs.
- c. The ability to identify, formulate, and solve engineering problems; and
- d. The ability to use the techniques, skills, and modern engineering tools required for engineering practice.

3.8 Industrial Engineering (IE)

Industrial Engineering is concerned with the design, development, and construction of system components of man, machine, and equipment, using specialized knowledge and skill in the technical, economics, and natural science, as well as the principles and methods of engineering analysis and design to specify, predict, and evaluate the result of such system^[20]. It also plays important role in denim textile industry. Because using IE we developed our denim production. Without IE we can't get more products, day by day it has used more. It has some responsibility in denim textile: Capacity measurement, Work evaluation, Time analysis, operator performance, Verification, WIP (Work in Progress and Line balancing.

3.9 Finishing Department

Before to packaging garments into poly bags, finishing activities are carried out. A finishing department's primary duties include thread reduction, garment inspection, and ironing^[21]. The wrapping division of the finishing department is where garments are wrapped, labelled, and stored. Without finishing department, we can't develop our denim sector. Finishing department is essential for denim sector. Without it we can't import products that's why we can't earn money that's why is important for denim sector of textile.

It has some function of finishing in denim textile industry. All these functions is very much important of industry. Without finishing we can't import the products that's why it is important of our denim textile section.

Thread Trimming

Thread paths and thread chain stores are not neatly trimmed in the stitching department. Helpers in the finishing department trim uncut threads and thread tails in garments. Defects in garments comprise uncut and loose threads.

Aesthetic and measurement inspections

At the finishing stage, all garments are graphically and quantitatively checked. Finishing checkers regularly check the whole garment from the inside out. Garment detailing, such as care labels and trimmings, are checked.

Button attach and Butting holing

In the finishing section, products to trimming such as buttons, grab buttons, and eyelets are attached.

Stain removal

Stains and spots can be detected on clothing. Prior to pressing, spots are eliminated with a hand spot gun or a stain remover system. Machine washing helps eliminate

dust and stains. As a result, the finishing department frequently washes items within the department.

Mending and repair work

Stitching and fabric defects in defective garments may require repair. Rather than sending damaged clothing to the stitching department, all repairs are completed in the finishing department.

Ironing clothing

Steam irons have been used to iron garments. This is done to get rid of creases in the fabric. Steam pressing are used to set parameters for knitted clothes. Garment pressing is done using vacuum pressing tables.

Folding and tagging

Pressed items are folded to a predetermined size. A Kimble gun or threads are used to attach tags such as price tags and hang tags on the clothing.

Packing the garments

Finally, the garments are folded properly and placed in poly bags according to the customer's specifications. After that, the individual poly bags are packaged into larger cartons.

Packing list creation

The shipping in-charge creates a packing list for the package. The finishing department notifies the concerned

merchant whenever an order's packing is completed.

Internal shipment audits

Quality department performs internal shipment audit in the finishing department. Prior to the final inspection, this audit is conducted.

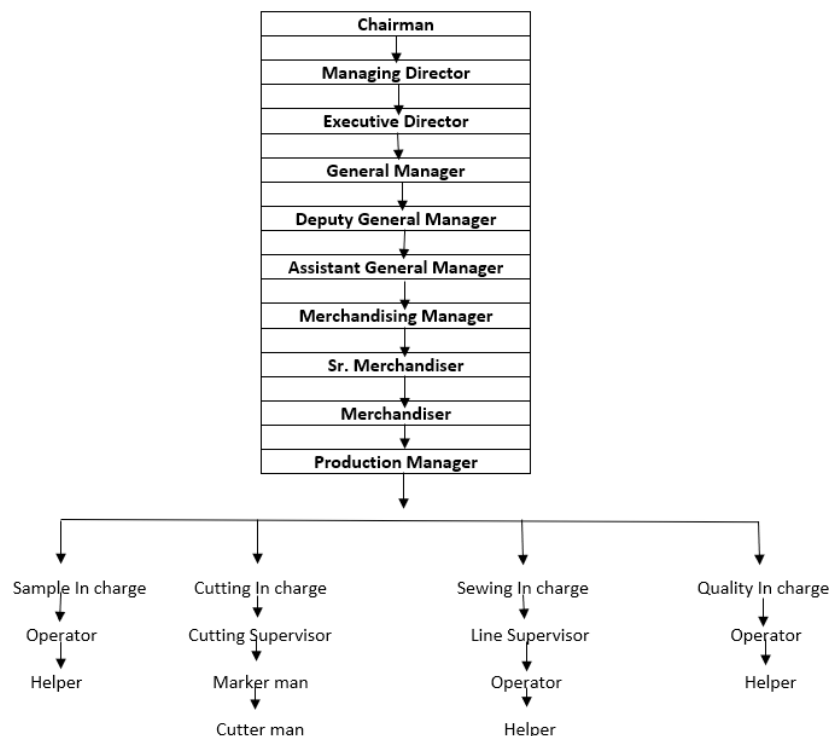
Reporting and documentation

The finishing department, like the other departments, keeps a list of manufacturing records for pressing and packing. All these functions are important of denim sector in textile finishing.

4. Manpower Organization

Manpower planning is one of the major activities which consumes a significant amount of time and effort of an IE at a denim textile manufacturing unit. Companies struggle to arrange and allocate desired machines and manpower to get the intended output, and many a times, unavailability of machine and manpower is taken as an excuse to hide or cover up the failures [22]. Though allocating the right people to the right work with the proper gear is a delicate problem, most this do not place enough emphasis on it. An imbalance among requirements (manpower or machinery) and actual allocation can create massive imbalances in the process, which can stymie the setup's performance. It is quite essential for denim sector of textile.

Table 3. Manpower organization in denim industry [23]



5. Raw Materials Used in Denim Industry

Different type of raw material used in denim textile industry such as fabric, button, zipper, sewing thread, label, different quality yarn, fibre, Dye stuff, Chemical and auxiliaries. In any production-oriented denim textile sector, raw material is an object. It is necessary for continuous productivity and increased fabric. Cotton, jute, wool, raw silk, and synthetic goods are being used as raw materials in the denim textile industry [24]. Textile raw materials are chosen based on the company's manufacturing policy, such as whether it is a composite mill or merely a spinning, weaving, or dyeing / finishing operation. All of these combine a good production of denim textile industry.

5.1 Fabric

Denim is a 100% cotton fabric that is woven in a twill weave with different colours of warp and weft yarn [25]. On the fabric surface of denim fabric, one color dominates. Denim is a common raw material used in the clothing industry. Denim fabrics are mostly made of cotton, while hemp denim is occasionally found. Denim fabrics are commonly used to make jeans, work clothing, and organic futon and pillow casings. Different types of denim fabric used such as Colored denim, Bubble gum denim, Denim from fox fiber, Crushed denim, Vintage denim, Ecu denim, Marble denim, Reverse denim [26].

5.2 Button

A button is a little round disc that is generally sewn onto an article of clothing or garment to close a gap or to enhance decorative feature. Buttoning is achieved by sliding the button through a stitched slit called a buttonhole or thread loop in the fabric. Buttons are fashionable because they decorate and improve the appearance of denim textile clothes. It is mostly used for increasing the appearance of garments [27]. Different types of button used in denim textile section as example: Plastic Button, Metal Button, Wooden Button, Fabric Button, Shell Button Glass Button, Pearl Button, Ornamental button, Animal skin button, Ceramic button [28].

Sizes of Buttons

The button's size was calculated by its application. Shirt buttons are most often small and close together, but coat buttons are larger and split out [29]. Buttons are usually measured in lines (also known as lines and abbreviated L), with 40 lines surpassing 1 inch. For example, 16 lines (10.16 mm, standard buttons for men's shirts) and 32 lines (10.16 mm, standard buttons for female's shirts) are two most common button sizes (20.32 mm, typical button on suit jackets).

Table 4. Size of button

Ligne	Millimeters	Inches
14	8.9	0.37
16	10.1	0.41
18	11.4	0.38
20	12.7	0.51
21	13.3	0.53
22	14	0.57
23	14.6	0.59
24	15.2	0.63
27	17.1	0.67
28	17.8	0.69
30	19	0.75
32	20.3	0.83
34	21.6	0.86
36	22.9	0.88
40	25.4	1

5.3 Zipper

A zipper is an integral element of a garment that allows it to open and close. This is a type of trimming that can also be used as a garment accessory. In the apparel industry, the zipper is the most prevalent fastening device [30]. Zipper is essential raw material of denim textile sector. It consists of a slider with a tab, facilitating the opening or closing of two interlocking teeth or coil connected to a fabric tape strip. In making trousers, shirts and jackets, zip or zipper is an essential component used to open or close the garment's opening. Plastic zippers are not only more convenient for attaching garments, and they're also wind, dust, and waterproof, and they do not snag, stick, or rust. The innovation of plastic zippers also meant that they could be made in any color, allowing fashion designers another tool in their inventory. Many zipper used in denim textile industry such as Nylon coil zippers, Two way separating zippers, Closed-end zippers, Separating zippers, Continuous zipper chain, Metal teeth zippers, Molded plastic zippers, Pant zippers, Invisible zippers, Bag, zippers, Water repellent zippers, Lapped zippers.

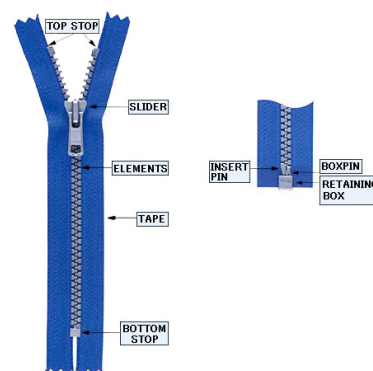


Figure 2. Main parts of a Zipper [33]

5.4 Sewing Thread

The apparel business employs a wide range of sewing threads. Sewing thread is a trim that secures the seams and ensures the functional features of a garment or other clothing product. The apparel business employs a wide range of sewing threads^[31]. Swing thread is a necessary trimming that is widely used in the denim garment industry. Sewing thread is used to create clothing in the denim textile section. Threads are made by twisted two or more filament yarns together. Single filament is also used on occasion. Sewing threads can be made of natural, synthetic, or mixed fibers. When it comes to closing and top stitching seams, core spun threads are ideal since they produce high quality seams. Continuous bulk filament threads are ideal for overlocking or cover stitch seams. Natural and synthetic fiber blended core spun threads are ideal for sealing seams on high-quality denim garments. Continuous filament threads are ideal for creating optimal seam strength in leather items. Sewing threads are yarns that've been designed and created to pass quickly through a sewing machine. During the product's useful life, they form efficient stitches without breaking or getting distorted. A thread's primary objective is to provide aesthetics and performance in stitches and seams. Sewing thread is essential raw material of denim textile industry. There are different types of sewing thread used in denim textile section such as: Linen thread, Silk thread, soft cotton thread, Mercerized cotton thread, Glazed cotton thread, Viscose thread, Polyester thread, Nylon thread, Aramide thread, PTFE thread.

5.5 Label

Label is another raw material to use denim fabric. Label is a part of garments which indicates the various instructions about the garments^[32]. Without any label a garment cannot be sold especially in export-oriented garments. The essential data like size of the garments, fiber type, care data, country of origin, company name, and trademark etc. It has some function: Product recognition, Suggestions for clothing sizes, promotes the product, customers' information Garments are categorized^[33].

5.5.1 Types of Labels

There are mainly two types of labels used in denim textile industry such as

- Main label
- Sub label

5.5.2 Main Label

The main activities specifically the buyer's brand name or logo, such as C&A, Tom Tailor, Zara, and so on. From the customer point of view, the brand name indicates emotional contentment with the product. Customers prefer brand labels since they are the only ones who are aware about the brand and who consume it.

5.5.3 Sub Label

There are five types of sub label in denim textile section such as

- I. Care Label
- II. Size Label
- III. Price Label
- IV. Composition Label
- V. flag Label

(I) Care label

Garments become dirty during end-use and it natural truth. These dirty garments are re-used by cleaning and ironing. For perfect caring of garments, some instructions are expressed by symbols which are called care code. The label in which, the care codes of a garment are placed called care label code. There are generally five types of instructions are used in a care label which are internationally recognized, called international care labeling code.

(II) Size label

Size labels vary from country to country. The different types of sizing for clothing include:

- a. 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30
- b. XXS, XS, S, M, L, XL, XXL
- c. small, medium and large
- d. 0, 1, 2, 3, 4, 5
- e. One size fits all

(III) Price label

Show the price of garment in different currency depending on country.

Composition label

Content labels identify the type of fabric that has been used to make the garment, for example, 100% Polyester, Silk, 100% Cotton. It is very important that you choose the correct content label to attach to your garment. When buying fabric, you should always insist that the supplier confirms the fabric content in writing (or with swing tags). In some instances, the care and content labels are combined into one and this will cut down on the number of labels used on the garment.

(V) Flag Label

Sometimes garments contain small flag of buyer’s country which is known as flag label.

6. Denim Washing





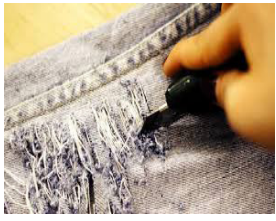
Denim washing is an attractive finish provided to denim fabric to increase its beauty and strength. Now-a-days denim washing is much popular both dry and wet washing process According to the fashion and appearance, there include new washing process and technology such as 3D or laser techniques ^[34]. In denim washing is done to produce effects like color fading with or without patchiness,




crinkles, seam puckering, hairiness, Pilling softened-hand feel, stabilized dimension etc. Most of the denim wash effect vintage look.

6.1 Denim Dry Processes

Dry processes are important part of denim washing. Day by day dry processes is much popular in denim washing. Denim’s dry process occurs before the wet process, and it alters the aesthetic look of the fabric through mechanical abrasion without influencing its construction or qualities. The garment takes on a good appearance after drying, and it also adds value to the product. The dry process is used to create fashionable clothes ^[35].

Table 5. Different types of dry processes in denim textile industry

Dry process	Description	Image	References
Whiskering	<p>Materials and ways: It requires abrasive paper or emery paper and some various ways such as by whiskering pattern, by Manual hand scrap, and by using laser Machine.</p> <p>Functions: It gives whiskered effect or fading effect on denim garments.</p>		[36]
Hand Scraping	<p>Materials and ways: After whiskering it requires abrasive paper, air dummy (horizontal), gum tape and Hand.</p> <p>Functions: This process removes the color or fade specific area of the denim garments.</p>		[37]
Tagging	<p>Materials and ways: Tag gun, tag pin, chalk and hand gloves are required for this process.</p> <p>Functions: It gives tagging effect at edge area of denim garments.</p>		[38]
Grinding	<p>Materials and ways: It requires Grinding machine and small size of stones are used in this process. This process is done manually.</p> <p>Functions: This gives old look appearance and creates high fashion denim garments.</p>		[39]
Destroying	<p>Materials and ways: It requires Grinding machine, grinding wheel, different size stones, niddle, knife, electricity, safety accessories. This process is done manually.</p> <p>Functions: It creates holes and worn-out white yarns which make garments unique and fashionable.</p>		[40]

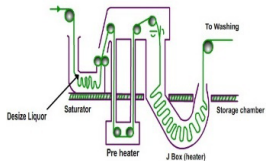
Dry process	Description	Image	References
PP Spray	<p>Materials and ways: It requires water, Potassium permanganate (.4- 15 gm/L) (standard stock soln = .4 %) 3. Acetic acid (as per need). It also requires P. Spray Cabin, spray gun, air dummy, water circulation system, musk's, gloves, safety shoes and apron, electricity.</p> <p>Functions: It gives white or yellowish and bleach spot randomly in the denim garments.</p>		[41]
Overall Crinkle	<p>Materials and ways: It requires resin 20% and water 80%. It also requires washing machine, trolley, hydro extractor, curing machine, tie, rope, and thread</p> <p>Functions: It produces special effect on denim garments.</p>		[42]
3D Crinkle	<p>Materials and ways: This process is done manually or semi automatically using resins like low formaldehyde or DMDHEU (Dimethylol Dihydroxy Ethylene Urea) type resins Various supporting auxiliaries are used for this process.</p> <p>Functions: It gives 3Dimensional effect on denim garments at the thigh, hip and back knee area.</p>		[43]
Laser	<p>Materials and ways: It requires laser machine, leather hand gloves, goggles for safety and photoshop illustrator app.</p> <p>Functions: It creates whiskering or burning effect on the denim garments.</p>		[44]





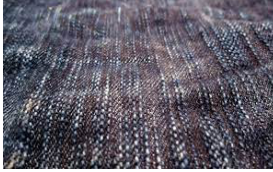


6.2 Denim Wet Processes


Following the dry process, wet processes including as desizing, enzyme washing bleach washing as well as other washes are applied to the raw garment to get the beautiful. The garment goes through multiple chemical processes in this procedure to eliminate contaminants from various

production processes, give it a fresh look, soften it, and make it ready for the purchaser. In this paper shown the denim wet processes which is used in the denim textile industry. All the wet processes are important of our denim textile industry. Without wet processes impurities are included in the fabric so the products look unattractive, so it is important in denim textile sector.

Table 6. Different types of wet processes in denim textile industry

Wet process	Description	Image	References
De-sizing	<p>Chemicals & materials: Detergents, Soda, Hydrogen peroxide, Anti back Stainer, stone.</p> <p>Functions: This process removes size materials, increase luster and absorbency.</p>		[45]

Wet process	Description	Image	References
Normal/Regular wash	<p>Chemicals & materials: Just water and slight detergent and back Stainer.</p> <p>Functions: This removes starch, dust and dirt from garments.</p>		[46]
Stone washing	<p>Chemicals & materials: Pumice stone, perborate and optical brightener if necessary and softener.</p> <p>Functions: This process gives vintage look, irregular color fading and softness of the garments.</p>		[47]
Bleach washing	<p>Chemicals & materials: Sodium hypo chloride, Hydrogen per oxide, and Sodium hypo-sulphite.</p> <p>Functions: It gives Light BLUE shade, removes the starch present on the garments, removes the size material from the garments and achieves soft effect on the garments.</p>		[48]
Enzyme washing	<p>Chemicals & materials: Neutral/Acid enzyme: G.B ZYME, Bio polish.</p> <p>Functions: This process removes floating fiber, smoothen surface of garments, gives high-low effect, increase luster and removes starch, sizing material.</p>		[49]
Acid washing	<p>Chemicals & materials: Stone, Potassium permanganate and Phosphoric acid.</p> <p>Functions: This gives Vintage/old look, Irregular fading and Softness.</p>		[50]
Waterjet fading	<p>Chemicals & materials: It does not need any chemical just need hydro jet and water.</p> <p>Functions: This increases the surface finish, texture, durability and other characteristics of denim garments.</p>		[51]
Dip dyeing	<p>Chemicals & materials: Pigments, direct dye, bleaching agents and dip dyeing machine.</p> <p>Functions: It creates special effects on denim garments.</p>		[52]
Pigment washing	<p>Chemicals & materials: Pigments, softener and water.</p> <p>Functions: It gives vintage look, softness, and fading effect.</p>		[53]
Tinting	<p>Chemicals & materials: It can be used different types of dyes like direct dye, reactive dye, sulfur dye and pigment colors.</p> <p>Functions: It gives new fashion designs and vintage or muddy look on the garments.</p>		[54]

Wet process	Description	Image	References
Tie dyeing	<p>Chemicals & materials: It can be used direct dye, pigments and bleaching agents for tie dyeing.</p> <p>Function: It makes different patterns and bleaching effect on the garments.</p>		[55]

7. Mathematical Calculations in Different Sections

7.1 Warping & LCB (Long Chain Beamer)

Warping is the process of preparing yarn for weaving. It is the process of moving many yarns from a creel of single packages to a beam. The yarns will be placed onto the beam in a parallel sheet. The yarn arrangement in the dyed rope is transformed from a rope to a sheet shape in Long Chain Beamer. The rope pull from the can is moved upward to a guiding device in the Long Chain Beamer. The guiding device is probably positioned in the ceiling above the can. The following calculations are used in warping & LCB section.

- 1) yarn tension = $\frac{5905}{\text{count}} \times 0.075$
- 2) core length = $\frac{\text{Bag weight (gm)}}{\text{No. of core}} \times \text{count} \times 1.6933$
- 3) yards = meter $\times 1.09361$
- 4) operator production = $\frac{\text{warp length} \times \text{No. of ball warped}}{\frac{\text{Total no of ball}}{\text{warp length (mtr)} \times \text{Total Ends}}$
- 5) Estimated yarn kg = $\frac{1.6933 \times \text{count} \times 1000}{\text{Total break} \times 1000000}$
- 6) Break % = $\frac{\text{Set length} \times \text{Total Ends}}{\text{Total yarn kg} \times 2.2046}$
- 7) Lbs/break = $\frac{\text{Total break}}{\text{Total productionn (length mtr)}}$
- 8) Operator Efficiency = $\frac{\text{RPM} \times \{\text{Total mun} - (\text{break} \times 2)\}}{\text{Total productionn (length mtr)}}$

7.2 Dyeing & Sizing

Dyeing is the process of incorporating yarn with color. It's done by soaking the yarn in a dyestuff-containing liquid. Indigo is the most frequent dye for denim. Because only the warp threads are dyed, the weft yarns are left natural undyed or bleached, denim is blue on the front and white on the back. On the other hand, sizing is used to improve the characteristics of surfaces. Sizing the warp yarn is necessary to avoid yarn breakage and, as a result, weaving machine production stops. The following calculations are used in dyeing & Sizing section.

1) Count

N = Count
 L = The length of the sample
 l = The length of the system
 W = The weight of the sample
 w = The unit of the weight of the system

Indirect system

$$N = \frac{L \times w}{l \times W}$$

Direct System

$$N = \frac{w \times l}{L}$$

2) Average count = $\frac{r1+r2+r3}{\frac{r1}{c1} + \frac{r2}{c2} + \frac{r3}{c3}}$; Here c1, c2, c3 are count with their ratio r1 : r2 : r3

$$3) \text{ weight of yarn (gm/mtr)} = \frac{\text{Total Ends} \times 0.59}{\text{Average count}}$$

Or = $\frac{\text{Total Ends}}{\text{count} \times 1.6933}$

$$4) \text{ Total weight of yarn (kg)} = \frac{\text{Total length} \times \text{Total Ends} \times 0.0059}{\text{Average count}}$$

$$5) \text{ Dossing} = \frac{\text{m/ speed} \times \text{shade} \times \text{weight of yarn (gm/mtr)}}{\text{Feedsolution (g/L)}}$$

$$6) \text{ Total Dossing} = \frac{\text{Total length} \times \text{Dossing}}{\text{M/c speed} \times 100}$$

$$7) \text{ Box dye amount} = \frac{\text{shade} \% \times \text{Total volume}}{\text{M/c speed} \times 1000} \text{ or, } \frac{\text{g/L} \times \text{both volume}}{1000}$$

$$8) \text{ Dye} = \frac{\text{shade} \% \times \text{pick up} \%}{\text{stock solution}}$$

$$9) \text{ Volume of Black bath} = \frac{\text{Box g/L} \times \text{Total bath volume}}{\text{Feed g/L}}$$

$$10) \text{ Pick up} \% \text{ (sre chemical)} = \frac{\text{Total weight of sizing chemical}}{\text{Total weight of yarn}} \times 100\%$$

$$11) \text{ RF} \% = \frac{\text{Total chemical} \times 100}{\text{volume of water} \times 1.8}$$

$$12) \text{ viscosity} = \text{RF} \times 1.54$$

7.3 Weaving

The process of weaving the warp and weft threads into the actual selvedge denim fabric takes place on a shuttle loom. The shuttle loom was popular in the past, although it has now been largely superseded by modern weaving machines. Selvedge denim, on the other hand, is still woven on shuttle looms to produce a genuine and high-quality fabric. The following calculation are used in weaving section.

$$1) \text{ Reed Space} = \frac{\text{Total Ends}}{\text{EPI}}$$

$$2) \text{ EPI} = \frac{\text{Reed Count} \times \text{No. of yarn pass into reed eye}}{2}$$

$$3) \text{ No. of warp in yarn selvedge} = \frac{\text{selvedge width in cm} \times \text{EPI}}{2.54} \div \text{selvedge width} = \text{for cotton}$$

1.50 & for 1.70

$$4) \text{ Loom Speed} = \frac{\text{motor PPM} \times \text{moto pully diameter}}{\text{loom pully diameter}}$$

$$5) \text{ Loom efficiency percentage} = \frac{\text{Actually prod}}{\text{calculated prodn}} \times$$

$$6) \text{ Moisture regain\%} = \frac{\text{yarn weight} - \text{Dried yarn weight}}{\text{Dried yarn weight}} \times 100$$

$$7) \text{ Moisture content\%} = \frac{\text{yarn weight} - \text{Dried yarn weight}}{\text{yarn weight}} \times 100$$

8) Cloth cover factor,

$$\text{warp cover factor} = \frac{\text{EPI}}{\sqrt{\text{warp count}}}$$

$$\text{weft cover factor} = \frac{\text{PPI}}{\sqrt{\text{weft count}}}$$

Cloth cover factor = warp cover factor + weft cover factor - {(warp cover factor - weft cover factor) / 28}

7.4 Finishing

Fabric finishing is the final step in the denim manufacturing process. This is where the finished products are applied, and it can have a massive effect on how the cloth looks, feels, and fades. The following calculation are used as follows:

$$1) \text{ warp / length shrinkage (\%)} = (\text{Greigh pick} - \text{Finished Pick}) \times 100 \div \text{Finished Pick}$$

2) Skew (%)

$$A \rightarrow \text{skew(C.M)} \div 2.54 \times 100 \div \text{width (inch)}$$

$$B \rightarrow \text{skew(inch)} \times 100 \div \text{width (inch)}$$

3) Meter to Yards

$$A \rightarrow \text{length(meter)} \times 1.0936 = \text{yards}$$

$$B \rightarrow \text{length(yards)} \div 1.0936 = \text{meter}$$

4) After wash fabric shrinkage (warp/length)

$$= (\text{Finished Pack} - \text{after wash pack}) \times 100 \div \text{after wash pack}$$

** All mathematical calculations are collected from "Aaron Denim" (Savar-Dhaka).

8. Conclusions

This paper showed the denim sector of textile industry and also we describe the different section of denim industry. Denim sector is important part of textile industry. The country benefited from denim sector because day by day denim sector developed. All the section played a vital role in textile industry. The main aim of the paper is knowing all the section of denim industry and also how to be increased productivity. When we read this paper we can easily know about denim sector of textile industry. Denim plays a vital role in textile sector. Sewing section, cutting section, IE department, washing sector, finishing department all are included in denim sector. Above this section we can't imagine denim sector of textile industry. In this paper we have shown sewing problems and how to overcome this problem, washing defects and how to

minimize the washing problem, cutting measurement and function of cutting, industrial Engineering purposes and CAD system which They've played a key role in reducing the cycle time, increasing accuracy, and placing clothes products in stores significantly closer to when customers need them. Bangladesh is exporting denim products approximately 200 million pieces every year all over the world. Bangladesh is recognized as one of the most significant centers for denim apparel production in the world. It ranks as the second-largest denim garments exporter after China (According to WTO). The statistical review shows that the denim sector of Bangladesh plays a very important role in the denim market all over the world. Especially after the denim sector of China, Bangladesh's position. Seeing such a huge achievement in the denim sector of Bangladesh, other countries can also become competitive. Denim garments are one of the most necessary parts of the textile sector in Bangladesh. In the global market all over the world, Bangladesh is now more prominent as a supplier of denim products. Therefore, Bangladesh will be more interested to take the denim sector to the first position. By reviewing this paper, the manufacturer of denim garments in Bangladesh and other countries will be more interest and improve their economy by exporting their denim products all over the world. Finally, it will help to develop the economy and people living standards of Bangladesh.

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