Faculty of Engineering

Department of Textile Engineering

REPORT ON

T-Shirt Sample Development

Size-M

Course Title: Project (Thesis)

Course Code: TE 4214

Submitted By

Md Golam Robbany ID: 172-23-5115

Supervised By

MD MASHUD RAIHAN

Assistant Professor

The Report presented in Partial Fulfillment of the requirements for the degree of Bachelor **of Science in Textile Engineering**

Advance in Apparel Manufacturing Technology

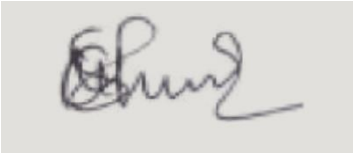
Faculty of engineering

Department of Textile Engineering

Approval Sheet

This study titled the "Sample Development of T-Shirt" prepared and submitted by **Md Golam Robbany** (ID: 172-23-5115) to fulfill the requirement of the degree of **Bachelor of Science** in at **Daffodil International University** on July 2025

TEXTILE ENGINEERING has been reviewed and hereby, it is proposed to be recommended and approved and accepted.



MD MASHUD RAIHAN

Assistant Professor

The Report presented in Partial Fulfillment of the requirements for the degree of Bachelor **of Science in Textile Engineering**

Supervisor

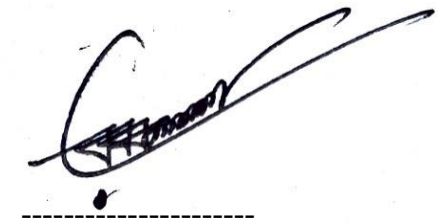
Declaration:

The present thesis has not been presented anywhere earlier either wholly or in part for the acquisition of any degree or diploma at any other institution or university. All the information, facts, and data in the following are only gathered by using trustworthy sources and proper credits are given in places where it was indispensable.

We also state that our scholastic undertakings in this thesis are the results that are taken on by the industry-based case studies, in factory observations as well as advice of the faculty and the professionals in the industry.

With due respect we submit this thesis as a mandatory requirement towards achieving the degree of a B. Sc. Textile Engineer in Daffodil International University.

Submitted By:-



Md Golam Robbany

ID: 172-23-5115

Department of Textile Engineering

Daffodil International University

Acknowledgment

I also wish to show my gratitude to sampling and production teams who demonstrated their invaluable cooperation and unconditional support during the process of this research. Their experience and commitment as well as practical participation played a significant role in addressing the challenges and accuracy and quality of the process of developing the sample.

Dedication

This report is wholly dedicated to our dear parents who have supported us heavily, motivated us, and sacrificed a lot and enabled us to study Textile Engineering. We have always had the biggest support in this journey because of their continued inspiration and love.

Abstract

This thesis is going to address the detailed method used to make T shirt sample models as the process is of important concern to the garments manufacturing cycle. Sample is a prototype step, and it makes sure that the end product will match specifications of buyers, i.e. design, fit, fabric and quality. The paper investigates some of the important stages - the receipt of the tech pack and the selection of raw materials, pattern making, sewing, quality control. The focus is especially on the importance of the sample development process in terms of the minimization of errors during the bulk production, decrease in lead times, and an increase in buyer satisfaction.

Issues like the communication gap between design and production departments as well as variation in materials are also dealt with. By implementing the case studies and practical observations in the textile industry, the research will calculate best practices to streamline the sampling process.

As revealed, the study stresses the role of coordination between merchandising, production, and quality control units in supplying the correct examples that gain confirmation of orders. The work will be of help to textile engineers who need to improve efficiency and quality of the produced textiles especially T-shirts.

Table of Contents

Chapter 1: Introduction.

T-shirt as one of the most adaptable and the most popular clothes internationally is an important tool in the clothes market. Due to the rise in demand of fast fashion and individualized clothing, this battle between accuracy and efficiency of sample creation is more important than ever. Sample development is the sketch of the mass production process in this way manufacturers and buyers can check the quality of garment, fit, etc. Quality of garment, fit, design, and construction can be checked before the finalization of order.

The textile industry operating in the global competitive market is always under pressure to produce standard goods, provide them at the right time and at the optimum cost required by the buyers. In this thesis, the step-by-step development of T-shirt sample model is considered starting with the development of the initial tech pack, up to the selection of fabrics, pattern making and sample approval.

It is also discussed how the process of sampling is encountered and why coordination among merchandisers, sampling units and production divisions plays a crucial role. This research paper is aimed at determining viable solutions to enhancing the sampling development process and also to make certain that the process is healthy technically as well as commercially.

1.1 Study background

Within the very competitive international garment industry, T-shirt production takes a big share because it has high demand, simple and it can be liked by many consumers. Sample development is one of the most important stages of T-shirt manufacturing process that forms the basis of bulk ordering and acceptance of buyers. An aesthetically and technically complete sample does not only show the design, fabric, fit and finish of the final product but also shows the technical competence and after- sales desire of the manufacturer.

The sample is a reference criterion to the production units and provides the confidence that the buyer of the product has in regard to standards of the product before an order can be placed. Buyer’s decisions on making orders and the quantity to order in most of the cases depend on the sample only. Therefore, a proper sample development is necessary to create the trust and reduce the production errors as well as the customer satisfaction.

The paper intends to present the process of developing a T-shirt sample, evaluate its contribution to the supply chain and, finally, establish how the textile and the apparel manufacturing industry can ensure quality, communication, and the lead time are optimized.

1.2 Significance of Developing T-Shirt Sample

The creation of T-shirt sample is one of the most important stages of garment manufacturing process, which is the basis of the buyer acceptation and the order placement. It indicates the quality, fit, and workmanship of the manufacturer and assists it to ensure that all the technical specifications are satisfied. An efficient sample reduces errors during bulk production, communication between departments and it instills confidence on the buyers. After all, sample

development is the crucial process of obtaining the orders and the image of a manufacturer in the competitive textile market.

1.3 Study objectives

- Diagnose of the current issues
- Better choice of materials
- Improve the pattern-making and the design
- Improve the manufacturing
- Review customer comments
- Hofstadter called it: Analogy Rule Analogy Rule

Improve the work flow of the T-shirt development as a whole

1.4 Study Panorama

The main concern of the current research is to examine the entire course of T-shirt sample manufacture in the apparel sector. It will determine the main steps, procedures and pitfalls of developing the correct samples which will be according to the specifications of buyers. The paper will also aim at coming up with an estimate of how quality control, buyer satisfaction and order confirmation has been affected by effective sample development, and how they can be improved overall to boost the efficiency and minimize production errors.

Chapter 2: : Literature review

2.1. Description of Sampling Garments

Apparel industry, sampling of garments is a pre-production process or procedure in which teasers of the garments are created to represent the whole product. The samples also allow the manufacturers and buyers to examine on the design, fitting, fabric quality and craftwork before the mass production. Any issue with good sampling can be identified at a very early stage thereby removing the errors and reducing the Braking. It normally consists of proto samples, fits samples and pre-production samples, which are to show the various garment parts involved. Proper sampling boosts the confidence on customers, has a consistency in the product and an easy production schedule thus a very pertinent step in the making of garments.

2.2. The Samples of garment there are different samples types i.e. proto, fit, size set, etc.

When producing T-shirt samples, various samples are produced in an effort to ensure quality as well as satisfaction to purchasers. The first set is called proto samples that assist in looking into details of design, fabric details, and construction details. Fit samples focus on what a piece of clothing would appear on either human or a model. Size sets are size set (e.g. S, sets of M, L, XL etc.) to ensure that the fit and workmanship is the same across the size range. Lastly, there are the pre- production runs or the pilot runs, which are done to utilize the finishing production materials so as to ascertain whether the firm is capable of going full swing with large production. The specimens could be vitally useful to ensure accuracy and avoid errors of the production.

2.3. The Part of Merchandiser in Sampling

The merchandiser would be rather a very necessary person as far as the production of the T-shirt is concerned since he/she should be the most important person between the buyer and the production team. They are also communicating in the departments e.g. the design department, pattern making as well as quality control department and even with the suppliers so as to make the selection of the material. The merchandisers will keep a track of the development and will authorize in a fruitful way and respond to the feedbacks, thus, avoiding delays. They do a proactive move to make sure that the progress of the samples are according to the expectations of the buyers and also provides a shift to the bulk production which is also quite crucial in giving the right time and once the buyers are contented.

2.4. Tech Pack and Buyer Requirements significance

Tech pack is a list of specification provided by the buyer in a details package enclosed to make the provision of all the required specifications of developing T-shirt sample like the kind of fabric, color code, size of the shirt and the required trims, printing and carving. It forms the biggest principle used to ensure that the manufacturers have a feeling to produce the sample as close as possible to expectation of a buyer. Buyer requirements that have been maintained on the tech pack include less duplication of patterns, quicker authorization and limitation of error. The proper

application of the tech pack and its cognizance shall be instrumental in the actualization of good quality samples and the creation of orders that shall be verified in due time.

2.5. Research Findings in the Past

The discussions above portray the aspect that the sample development is a critical component of buyer satisfaction and adequate order confirmation in garment industry. Rahman et al. (2018) have also told us that well samples which eliminate errors and decrease lead time in the manner of manufacturing. According to Hossain and Sultana (2020), good communication and elaboruffled tech packs lead to an improvement of the specimens. As observed in the above study, isolated working of merchandising, pattern making and quality control departments was very crucial in reducing the rework (Islam, 2019). In addition to that, a significant relationship was found by Singh and Das (2021).

There are the high quality samples and creation of comfortable garment and good fit between the producing of a T-shirt.

Chapter 3: Methodology

I. Target Customer Profile-Market needs

The first step of developing an impressive sample of T-shirt ought to involve actualization of intended recipient and market needs of the product. This fundamental study will help in positioning the product on what the buyer wants and what is fashionable in the market.

3.1. Material Sourcing

The sources of materials are:

- Vendors trusted locally
- Quality Local Suppliers
- Buyer Nominated Suppliers (BNS)
- fabric libraries or stock houses (sample in a hurry)

3.2. Methods

Flow Chart of Sampling Process:

The basic sampling process as flow chart is given below-

Fabric Booking to RND

↓

Trims and accessories booking to procurement

↓

Pattern Making

↓

Cutting According to Pattern

↓

Print Embroidery

↓

QC Check (Quality Check)

↓

Planning

↓

Sewing

↓

QC Check (Quality Check)

↓

Finally Packaging

Table 1 Tach pack Measurement Sheet, Size-M

Description	Size(M)	Unit(cm)
1/2 Chest Width		49
1/2 Waist Width		48
1/2 Bottom Width		48
Shoulder Point to Shoulder Point		44
Back Neck Drop		2.5
Front Neck Drop		12
Front Neck Width		16
Shoulder Seam Length		14
Armhole Straight		22
Sleeve Length from Shoulder		21
1/2 Sleeve Opening		19
CBN to Bottom Hem		65
Sleeve Hem Height		2.0
Bottom Hem Height		2.0
Neck Rib Width (Flat)		1.0
Neck Width Seam to Seam		17

3.2.1. Pattern making by hand

Patterns in conventional context are hand drawn on brown paper or pattern boards. Traditionally, patterns are manually marked on brown paper or patterns boards.

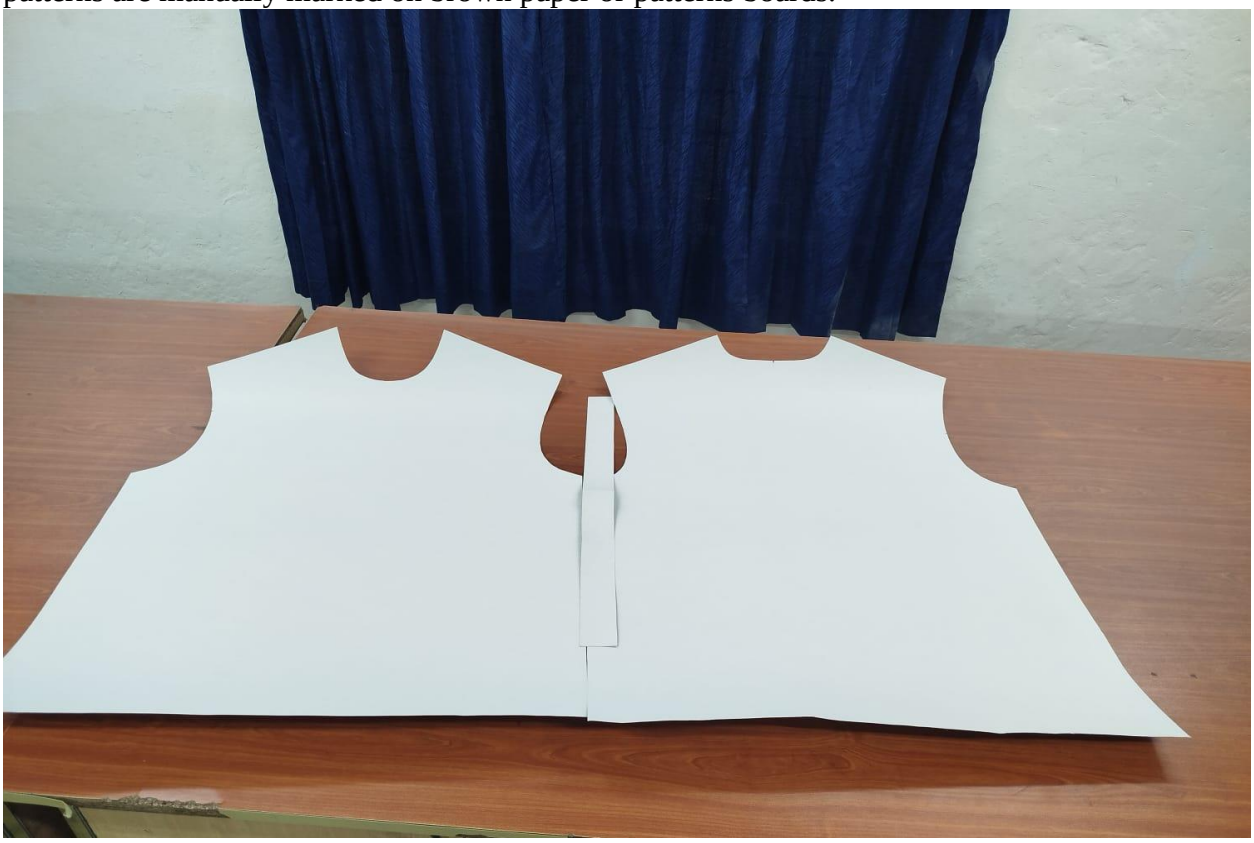


Figure.1.1: Manual Pattern Making

Tools Used:

- Measuring tapes and rulers ifacts
- French curves
- Master scale of patterns
- Set square
- Notcher and tracing wheel
- Cardboards or Brown papers
- Make the sketch of the basic block (T-shirt shape of basic blocks) with the body measurements.
- Add design options (e.g. neckline, the length of the sleeves).
- Label, mark notches, shallows, grainlines and seams.
- Test/Toile/Sample fitting: make a test cut with or without fabric or muslin and test it.

Advantages:

- A greater accuracy and effectiveness
- It is easy to grade on several sizes
- Digital editing and archive
- Marking making, Incorporation of cutting

Steps:

- Enter the body measurements or use available digital blocks.
- Alternative design specification.
- Install seams, holes, notches and labels.
- Copy duplicate the pattern or feed to automatic cutter.

3.2.2. A Basic T-shirt Pattern Components

The usual T-shirt pattern comprises the following:

- Front Body
- Back Body
- Sleeves
- Neck Rib/ Collar
- Bottom Hem Allowance
- Armhole and shoulder joining

In every pattern piece, you will find:

- Grainline
- Notch marks
- Cutting instructions
- Size name and version

3.2.3. Pattern Grading

- Grading it will be patternmaking the various sizes and down the base (sample) size.
- Manual Grading It is carried out assisted by pattern sets of nested patterns and rules concerning increments in size.

Purpose:

- To form the set of patterns in bulk production so as to.
- So as to fit on all sizes.

3.2.4. Fit Sample and Analysis

- Having decided on the pattern:
- A prototype or a fit sample is done with a real or a substitute fabric.
- It is patterned after a fat mannequin, fit model.
- The pattern is adjusted in the event of imperfection observed within the fit, balance or proportions.

Typical problems fixed:

- Armhole tightness
- Posture: drop of shoulder
- Neck etching
- Baffling of sleeves issue

3.2.5. Analysis and Needs Market Research

- On identification of market trends, there is done:
- Trend forecast (e.g. WGSN, Pantone)
- Competitor's analysis
- Social sites (Instagram, Pinterest, TikTok)
- Buyers purchasing history and seasonal requirement
- The needs which might be: Eco-friendly fabric
- Water-repelling features
- Neutral styles based on gender
- Minimalistic style design

This fact can assist in setting the course of the product in the terms of both functionality and style.

3.3. Gathering Inspiration and Making down Sketches

Once you have decided on the target customer and the needs of the market, it is worth saying that it is a right time to get some inspirations and embark on the conceptualization effort.

3.4. Gathering ideas

Design sources of inspiration material are collected in a variety of ways:

- Fashion magazines and look books
- Street wear fashion
- Airport collections
- Nature, art work, architecture, and culture
- Using of samples or mood boards by a buyer

It is also referred to as the mood board development stage which is the process of compilation of formulas of colors, textures, fonts (in case of prints) and sources of clothes in the form of a visual list.

3.5. Drawing the Preliminary Ideas

- As per motivation and preferences of buyers:
- The sketches (the drawings) include:
- Front and back shape of the T-shirt
- Sleeves and collar style
- Light and printing size
- Seams etc., (e.g, hems, topstitching)

At this stage a number of variants of the design are created in an effort to leave the buyer or the head of design with a selection of buttons.

3.6. Technical

Design sketches are then converted into technical drawing and the correct measurements, stitches and position are added to it in such a way that it could be readable to the factory.

3.7. Completing the Design: Theme, Color, Pattern and Style requirements

The final design is adopted but after liking sketches and remarks and that is when they are at the stage of developing samples

3.8. Design Theme

The topic depicts the emotion and the concept of the collection or the T-shirt. Examples include:

- City street fashion
- Little informal
- Sportswear and active wear 111

Vintage Retro

The choice of fabric, graphics and font and cuts are determined by themes.

3.9. Choice of color

The color is essential in brand identity and appealing to the consumers. Choice of colors is made according to:

Pantone Color standards

- Seasonal Tendencies (palettes of spring/ summer or fall / winter)
- Cultural tastes of the region the customer resides

The design concluded is:

- Garment background color
- Print/embroidering colors mix

Comparison of color on trim (neck rib, sleeve end etc.)

3.10. Graphics and Pattern

- Print type (Placement print, all over print)
- Motif style (e.g. geometric, floral slogan)
- Screen, sublimation Print, heat transfer techniques
- The patterns size, location and recurrence are black and white regarding sampling

3.11. Style Specifications

- The style specs are drawn out to comprise of:
- Fit type: slim fit, relaxed and oversized
- Length of sleeves: Short, long, cap sleeve, raglan
- ·Neck: Crew cap, V neck, Henley, Polo
- Stitching information: Flatlock, cover, double needle
- Size chart tolerance on all the sizes

All of this is gathered and compiled in a tech pack and sent to the pattern maker and sample development team.

3.12. Introduction

Pattern making: the art of designing of fashions is fashion designing through pattern making. It involves converting the design idea to templates or pattern that will be utilized in pattern cutting and garment making. Three factors namely; fit, shape and built of T-shirt require the right patterns. The chapter elaborates the machines, techniques and processes of making T-shirt designs and the rationale behind the use of such designs as a way of ensuring the satisfaction of buyers.

3.13. Pattern making objectives

1. Project the 2-dimensional drawing to 3 Dimensional wearable one
2. The size chart should match the measurement of the clothes.
3. Maximize material by wasting as little as possible of fabric
4. Minimize routine and rejection on the sample screening

3.14. Evaluation and Testing of Materials

- Prior to the utilization of any material in the sample, some quality tests are undertaken:
- GSM Measurement
- Shrinkage Test
- Colorfastness Washing and Rubbing
- Stretch Recovery (rib and spandex)
- Through strength test, thread strength is determined.

These guarantee that the products perform well according to standards and expectations of its buyers.

The Discussion of Sample Development of T-shirt:

The first-hand practical experience that I have gotten in the field by carrying out research into the designing of the T-shirt samples has been quite informative on the level of application of the concepts of textile engineering and the garment manufacture. Through this practical exposure we have gained more knowledge in regards to live decisions and critical thinking that is required in one of the steps, this is to include material selection to the end evaluation.

Figure 1.2 : Field Work Sample

Step: - 1: Concept and Requirement Designing

3.15. The determination of Target Customer Profile and Market Needs

The first challenge to realize a good T-shirt sample is that one must know the product they are targeting and the market needs. This is the initial research study that would help in coming up with a product that should fit in consumer patterns and expectations and patterns in clothing.

3.16. Profiling of customers

- Target customer profile- talks of a target customer. This includes:
- Demographics: Age, gender, occupation and level of income
- Geographical setting: and mode of fashionography: Weather conditions, fashion preferences in the area
- Lifestyle and Interests: Casual buyer, sport oriented man, young trendy clients etc.
- Buying Behavior: Price sensitivity, the desire/preference of environmentally friendly or branded clothes

Example:

Assuming the buyer is in Europe and she is seeking to target the youthful population as her target market, then design would be geared towards trendy products like oversize matches, punk prints, and pastel shades.

3.17. Needs assessment and Market Research

Market trends are determined as followings:

- - Fashion projections (WGSN, Pantone)
- -Analysis of competition
- Social networks (Instagram, Pinterest, Tik Tok)
- Seasonal bases buyer sales history and demands
- The identified needs can be the following:
- Environment friendly material
- 6) Moisture transfer sports
- Genderless fashion
- David-like decor design

Step- 2: T- Shirt sample development- Material Selection

3.17.1. Introduction

The selection of the materials is one of the most significant ones on the path of developing the T-shirt samples. The type, quality and nature of the material will directly influence the appearance of the piece of garment, the comfort, the wear ability, the cost of production and lastly the satisfaction of the customer. The materials to be chosen should satisfy the buyer specifications and they have to be functional and producible.

3.17.2. Important Factors to pay attention to when choosing the Material

- One has several things to put into consideration before choosing a set of materials:
- REQUIREMENT DOCUMENT 39 Tec Pack or Buyer
- The purpose towards which the garment is being used (Casual, athletic, promotional)
    - Season (winter or summer)
- Preference of Target Market
- Parameters of fabrics performance (stretchable, colorfastness, shrinkage)

3.17.3. Fabric

- Fabric makes the foundation of T-shirt and determines its main characteristics like comfort, appearance, and texture.
- Popular Materials:
- 100 % Cotton (single Jersey): Soft, biodegradable and breathable
- CVP (Chief Value Poly): Cotton rich fabric polyester, improved durability; CVC (Chief Value Cotton): Cotton rich fabric polyester, greater durability.
- The cheaper alternative, having a better color retention ability, is: PC (Polyester- Cotton)
- Cotton-Spandex Blend: elastic, in tight fitting styles
- Sustainable buyers Organic Cotton

Figure 1.3: 100% cotton Fabric

Fabrics Statistics Tested:

- GSM (Otherwise called Grams per Square Meter): T-shirts - they must be 140 to 180 GSM
- Yarn Count: 20s-30s (combed or carded)
- Knitting (Type Single) jersey, interlock, rib
- Shrinkage Control: Shrunk/Ready-made garment
- Softness and Colorfastness

3.17.4. Neck Rib (Rib Fabric)

- On necklines, and at the ends of sleeves:
- Material: cotton- spandex or Lycra mixes
- GSM: 220 - 260: as water proof, as elastics
- Features: Properly fits and does not stretch, matching skin and body fabric

Figure 1.4:: Neck Rib Fabric

3.17.5. Thread

- The quality of the seam depends upon the quality of sewing thread.
- Type: 100 pct. Polyester (most common), Cotton thread (special products only)
- Count- 40/2 or 60

Properties

- Tensile strength is forceful
- Abrasion is resistant
- Fabric to fabric matching

3.17.6. Labels and Tags

- Having been used in branding, sizing and care instructions
- The Main Label- the genuineness or logo of the brand
- Size Label: The label entailing the size of the other garments (M)

- Care: Washing, material composition, place of origin: label:
- Hang Tags: (we do not insist) hanging of samples optional

3.17.7. Accoutrements and wrapping (of submission samples)

- Polybag: printed/transparent size stickers
- Hang Tag String and Seal
- Sample Card/Tag: internally, that can be used
- Optional folding board (optional**)**

Figure 1.5: T-Shirt Final Output

Pattern Making is the Damage Accurate

- Can Avoid Common mistakes which can be eradicated by proper making of patterns Salient points In case the pattern making is made attentively then errors can be avoided
- Some of the things that may be avoided include: 1) following and others may be avoided:

- The way-true designs ensure:
- Quality aesthetics and fitting of apparel
- Less reworks and correction applications of production
- Plowed use of materials
- More buyer satisfaction and rates of approvals

Step:- 4: Sample cutting in T-Shirt Sample Development

3.18. Introduction

Sample cutting can be regarded as significant phase in the development of T-shirt sample. It would involve trimming the material following the designs which have been confirmed to cut small pieces of the fabric that would be sewn and joined. Cutting also should be accurate as every detail of fitting or shape and appearance of a garment is directly impacted. The new customer dissatisfaction or even rejection of the sample can be a projectile of a disparity on any point of this stage.

3.18.1. Sample Cutting Objectives

- To ensure that all the pieces of the garment are well-cut according to the patterns of the dimensions.
- To minimize waste of fabric and layout optimization.
- To stamp uniformity in terms of shape, size as well as seam allowances.
- Order to have the pieces of fabrics ready into the next process: stitching and assembly.

3.18.2. Preparation before Cutting

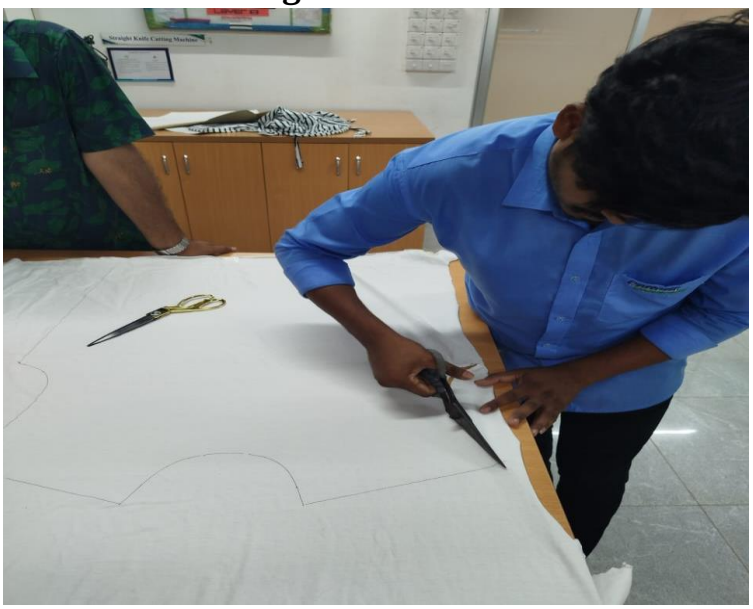


Figure 1.6: Before Sample cutting

3.18.3. Fabric Relaxation

- Why: Jersey type of knit fabric has the tendency to shrink and stretch upon knitting.
- How: Relaxing (by letting it go) lay down and then cutting; 12 to 24hrs.
- Outcome: It permits no distortion and accurate measurement after wash.

3.18.4. Inspection of fabrics

- Before cutting, clothing is checked as follows:
- Defects (holes, streaks, difference of shades)
- Color correspondence to buyer requirement
- GSM accuracy

3.18.5. Pattern Arrangement (Marker Making)

- The wastes are minimum as patterns are placed on the fabric in an optimized manner.
- Manual markers tend to be applied in marking of samples during cutting.
- In the industrialized factories the digital marker making software comes in handy with:
- Cloth efficiency 1
- Compatible with auto-cutting machine

3.18.6. Equipment and tools

- Scissors (to cut by hand)
- Straight knife or rotary cutter
- Cutting table
- Patterns on cloth e.g. weights or pins
- Tailor chalk or pen(to draw traces)

3.18.7. Step Cutting Steps

- Lay down into the cutting table with fabrics in the same manner as was done in laying piles, evenly on top of each other (it will be easy when sampling with 1-2 or 2-3 piles).
- Place pattern pieces on cloth as grainline and direction.
- Trace the outline with chalk or pen of cloth.
- Shape and allowance were used to trim the material in a careful manner.
- Tie those using little stickers or tags with notes on their size, design and name of part on each of them.

3.18.8. Checking of Accuracy of Cutting

- Make a measurement back to the pattern.
- Make sure that it has a similar side, i.e. front/back or left/right.
- Ensure that you have notches and matching points that allow the good stitch alignment.

3.18.9. Best Practices and Safety

- Wearing of cutting gloves is recommended in use of rotary cutters or knives.
- Keep cutting tools sharp and blade cleaning as well.
- Dry gently stretch fabrics so that they do not get distorted.
- Ensure that the tables are well lit and steady.

3.18.10. Problems in Sample Cutting

- The fabric movement at cut-off especially in knits
- Flick off Stitchwonacho numbering
- Disagreement due to ineffective placement of pattern
- The post cutting shrinkage when not relaxed fabric is used

Solutions:

- All in all, not to pin the pattern, and instead replace it with the weights of patterns
- Anti-slim mats which are cut on
- High end set ups involving vacuum suction table set ups

3.18.11. Significance of proper Cutting

When cutting is done accurately, then it guarantees:

Match making of clothes without the difficulty of making them fit Match up of clothes without some effort being used to make the clothes fit

- One fit through the sizes similarity
- Professional completeness and boxy lines
- Up to less wastage of material
- The incorrectness of the cutting may lead to:
- Sample rejection
- The lost resources and time waste
- Postponement at the level of buyer approval

Step:- 5: Assembly and Sewing in T-Shirt Sample Development

3.19. Introduction

The other most vital move in the case of stitching of the T-shirt samples is after cutting of fabric, that is, sewing and assembly. It is carried out by joining the cut parts of the piece of the fabric in a way that follows the pattern plan and levels of the fabric constructions. The total finishing, durability and the look of the T-shirt is also condensed on the level of sewing and accuracy of sewing numerous separate parts together. Sewing is more than structural soundness but it also has a large input on the buyer perception and satisfaction.

3.19.1. Sewing and Assembly objectives

- To neatly stitch the T-shirt specimen in consonance to the inkling and arrangement complimented
- To give appropriate fit, form and fit
- The smoothness in seam and topstitching To produce a good finish quality of seams and topstitching
- To make a sample like that one in which the buyer is satisfied with, in terms of functionality and looks

3.19.2. Set Up of Machines

Selection of various sewing machines is made on operations:

Figure 1.7: Machine Setup In Lab

- Overlock Machine (3/4/5 thread) supplied to running side seam, shoulder, arm hole seam
- Flatlock Machine- ornamental stitching or Heading
- Lockstitch Machine Lockstitch machine has an extensive application: it may be used to join labels, to attach pockets or unsophisticated assemblies.

1. Cover stitch Machine: Hemming sleeve and bottoms
2. Bar-tack Machine - to support areas of stress (optional)

3.19.3. Thread Choosing

- Strength and colorfast are done using polyester thread.
- Count: standard 40/2 or 60/2

- Thread must match or decorate the color of fabric.

3.19.4. Operator guidelines

- Those who operate are briefed with:
- Tech pack/ technical sheet
- Type of stitches and SPI (stitch per inch)
- Seam notches and matching notch
- Growth chart of garment construction

3.19.5. Assembly Process and Sewing

The general sewing and constructing order of a T-shirt sample:

Step	Operation	Machine Used
1	Butt shoulder seams	
2	Neck rib/collar Attach	Overlock
3	Topstitching the neckline (needing this)	Lockstitch or Flat lock
4	Use sleeves and put on arm-hole	Lockstitch
5	Side sew in seams (body + sleeve)	Overlock
6	Put labels (main, size, care)	Overlock
7	hem bottom and sleeve hem	Lockstitch
8	Last: topstitch/topstitching	Cover stitch

3.19.6. Sewing Quality Control

- Monitoring quality is done by:
- In-line protocol of major operation after the operation
- Checking:
- Stitches that are done in a staggered fashion or stitches that are missed
- Bunching/Wrinkling of material
- Seam matching
- Masking and seaming matching
- The number of SPI (Stitches Per Inch) is stored by the type of fabric (normally, it is 10-12 SPI)

Figure 1.8: Sewing and Assembly

3.19.7. Bit Finishing and Pressing

- After stitching:
- The sample t-shirt is cleaned by cutting off the loose threads.
- The seams are pressed in such a manner that they become extremely smooth and become clean.
- Further the character of any region in print or embroidery is splendidly pressed so as not to defile design.
- A successful finishing table will be steam or vacuum press table, which is commonly used in most of the factories.

Table: 1.2: Ordinary problems with sewing and assembly

Problem	**Cause of Problem**	**Solution**
Puckered seams		
Twisted sleeves	ERRA in store tension/ SPI	Reduce tension/SPI
Tattered stitches	Poor who are out of line or poor tension of the cloth	Do not use notches and man-handle textiles roughly
Irregular hems	Unsuitable thickness of the needle/wrong thread	Choose the right type of the needle/thread

3.19.8. The Essence of Proper Assembly and Sewing

- High quality stitching and exact construction lead to:
- Heightened fit and comfort
- Appended and finish - badge of the professionals
- More consents of the sample
- More buyer satisfaction
- Poor sewing c
- Refusal to the sample
- [c.f] Time and resource wastage
- And bad impression to the buyer may be caused by:
- Rejection of sample
- Waste of resources and time
- The buyer can be negatively disrupted

Step:-6: Fitting and Quality Check of Sample T-Shirt Development

3.20. Introduction

After sewing and assembling a T-shirt sample, a critical procedure, known as the fitting evaluation and quality inspection should take place. The measures above will ensure that the sample is able to fit, be comfortable, durable and of good quality since the satisfaction of the buyer is yet to be achieved before the bulk production is carried out. Proper and appropriate inspection will reduce the likelihood of rejection of sample and reworks which are costly.

3.20.1. Evaluation of the fitting

Objective of Fitting

- Checking the accuracy of the shape, silhouette and size of the garment to that in size chart.
- So that the wearer can be at ease and move freely.
- To check style features such as length of sleeves, neck line shape and good fit.
- To view the alterations that need to be done to fit or beauty during production.

3.20.2. Methods of Fitting

Mannequin Fitting: The sample is attached by pinning on a standardized sized dress model which in future will be of the desired size.

Live Model Fitting: Live model fitting involves a fit model (the size which will be going into operation) who goes into the garment and finds out how to fit in action.

Flat Measurement Comparison: The piece of garment is measured as a flat product and compared with the specification of tech packet or size list.

3.20.3. Area of Key Fitting Checked

- The shoulder width and the slope are present
- Sternum, (Anterior) chest gauze Chest bunion
- Fit of waist and hip
- Armhole ease and sleeve-Ease
- The neckline is comfortable and attractive
- -Garment length (Body garment and sleeves)
- Compositional balance and proportion

Figure 1.9: Fitting Sample with QC

3.20.4. Adjustments

- Suitable notes are taken.
- The recommendations on pattern adjustments or on corrections in the sewing are provided.
- Modifications are done and re-samples where necessary.

3.20.5. Inspection of quality

Objectives

- To achieve the sample which would be composed of definite quality features.
- To know them out before being transferred to consumers.
- To stay in line with the expectations and industries in the buying standards.

3.20.6. Inspection Criteria

Fabric Quality: Color, defects (holes, pulls and stains) and texture should be kept similar.

Stitching Quality Check: stitch should be smooth, of same length, good seams, should have no loosage and without seam allowances.

Accuracy in construction: Inspect assembly in the right sequence making a garment, location of labels, and refer to tech pack.

Measure-ups: See to it that there is tolerance correspondence between garment-size dimensions and size requirements.

Looks: Test the quality of prints, neatness of the design embroidered, and those on finishing.

These tests may be optional at sample stage: Durability Tests: Simple examination of seam-strength, and color fastness etc.

3.20.7. Tools of Inspection

- Rulers and measuring tapes
- Stitch checking magnifier
- Color and print display fan (lightbox)
- Quality inspection sheets or inspection checklists

3.20.8. Process of Quality Control

- Initial impression: It is undertaken during and after stitching.
- Inspection after final assembly/ pressing: complete inspection done after final assembly/ pressing.
- Buyer Feedback Review: Sample is gathered after submission in order to make improvements on a continuous basis.

3.20.9. Significance of Fitting and Quality Checking

- Gives initial consent of samples.
- Minimizes the increase in costs and delays in production.
- Forms the confidence of buyer concerning product consistency.
- Builds brand name due to the quality.

Step: -7: T-Shirt sample development Washing and Finishing

3.20.10. Introduction

During development of T-shirt sample, the skip-usuals are washing and finishing stages which must be adopted. The processes enhance the quality of Garment in terms of hand, appearance, dimensional stability and garment quality that the sample will be more like the finished garment that the buyer believes in.

3.20.11. Process of Washing

- Aims of Washing
- Elimination of impurities such as oils, starch and dirt which accumulate when manufacturing the fabrics and when assembling samples. To compact the fabric to become small hence preventing any additional shrinkage when washed by the consumer.
- To enhance feel of the fabric and the appearance.
- To clean the fabric and determine the wash resistance of the fabric and the reactivity of the fabric to washing and colorfastness of the fabric.

3.20.12. Types of washing in sample development

- Bio-washing: Enhances texture of fabric and softens the garment with the use of enzymes and also reduces fiber rubbing also known as pilling of the fabric.
- Stone washing: Gives the appearance of being worn but does not come in great use in samples due to much abrasion.

- Garment washing: It performs consumer washing so as to test colorfastness and shrinkage.
- Neutral wash: Removes the stress of washing and using stressful detergent to wash the garment but not distort the image.

3.20.13. Washing Parameters

- Temperature: 30-40 o C (Normally) to wash samples so as not to destroy.
- Type of detergent: A detergents that exhibit a mild pH of neutral nature is desirable.
- The time used to wash: it takes an average of 20-30 minutes.
- Drying: low-temperature tumble or air-drying to avoid the shrinkage

3.20.14. Targets of Finishing

- To have a better aesthetic value of the garment.
- To get dimensionally-stable after the wash.
- To provide shape retentive wrinkle resistance.
- To linish special finishes on demand (e.g. anti-pill, water repellent).

3.20.15. Common Finishing Methods

- Press / Steam Ironing: This removes the wrinkles, also assists in fixing the seams and also provides crispness.
- Softening: It entails using fabric softeners to create a good touch in the hand.
- Heat Setting: This is to fix the synthetic fiber and it does not distort.
- Sulfurizing; The in-order-of-contraction process done as control process to minimize on the future contraction.
- Calendaring is a mechanical finishing, which is applied even to smooth and glossy surfaces.

3.20.16. Measurement of Quality Shrinkage: through a comparison of laundry post shrinkage results with pre shrinkage laundry results of garments.

- Colorfastness Tests: Color fastness to washing, rubbing and light.
- Hand Feel Assessment: The browning of the surface and the softness of fabric is tested.
- Visual Viewing: Ensuring that there was no damage, discoloring or deformation that took place
- hacks Post Washing and Finishing
- Shrinkage Measurement: The method of determining shrinkage is through comparison of pre and post washed garments.
- Colorfastness Tests: The retention of color by washing, rubbing and light tests.
- Hand Feel Evaluation: The tests which involved the testing of softness of fabric and the texture.
- Visual Inspection: Ensure it was not damaged, discolored and deformed.
- Use of Washing and Finishing
- Gives the sample look and feel representative of the final bulk product.
- Increases the confidence of the buyer since a ready-to-wear garment is provided.

- Gets rid of complaints made after production over shrinkages or fading of colors.
- Brings the possibility to notice the defects of the material or construction in time.

Step-8 Final Evaluation and Feedback during development of T-Shirts Sample

3.21. Introduction

The last evaluation and appreciation exercise is the last but one of the important processes in the creation of T-shirt sample. It will state that sample materials become celebrated to be transferred into bulk production on bases of technical, aesthetical and buyer-specific specifications. The critical comments would prove to be very useful as far as what can be done to come up with a better and an improved quality.

3.21.1. Closing analysis

Objectives

- To have a good look at the sample in terms of fit, quality of construction, the stuffing and finish.
- To be sure that it has adhered to buyer specifications and tech pack.
- To identify any disparities or shortcoming that is to be corrected.
- The need to test the chance of producing the sample in mass.

3.21.2. Evaluation criteria

- Size and fit accuracy: Ensure that the group being sampled can fit the target customer group based on the size chart.
- Quality of Construction: Check how sound its seams are, the regularity of its stitches as also error free-ness.
- Material performance: check the feel of a fabric, color, shrinkage and quality of finish.
- Stylishness: inspect design solutions, the combinations of colors, the quality of print or embroidery.
- Standards: The label, tags and the package must be conforming to the buyer requirements and the regulations.

3.21.3. Tools and Techniques

- Physical (measuring tool: tape, rulers used)
- Using a sufficient lightening to conduct a visual inspection
- Shrinking report (test report), colorfast test reports
- Fancy dressing of mannequins or models

3.21.4. Feedback Sources

- Buyer Comments: First hand buyer feedback by the client/merchandising team.
- Internal Team: Comments of pattern makers, sample makers, quality inspector and merchandisers.

- Fit Model Feedback: Enlightened by the sample-wearer, the fit model feedback consists of information.
- Quality Control Reports Records of any deviations or issues that have been identified when making inspections.

3.21.5. Methods of Feedback

- Writing reports or e-mail reports
- Mental conversation or even video calls
- Survey questionnaires or check lists
- Digital workplaces (e.g. shared file folders, discipline work witch hunter systems, etc;)

3.21.6. Feedback Incorporation

- Review and Analyze: All the acquired feedbacks are summarized and studied so that some action can be taken.
- Decision Making: identify what is to be changed or enhanced.
- Make Changes: Change patterns, sewing processes or materials on suggestion.
- Re-sampling: In the event of the necessity, a redesigned version of the sample may be produced.

3.21.7. Feedback incorporation

- Reviewing and analyzing: The obtained feedbacks are discussed and learnt in a way that some action could be made.
- Decision Making: determine what is to be changed or improved.
- Make Changes: Change patterns, sewing processes or materials on suggestion.
- Re-sampling, in case of the need, a new version of the sample can be generated.

Chapter 4: Result and Discussion

4.1. Quality Control (QC) Test

Development of T-shirt sampled involved a systematic QC testing through a prepared checking sheet to realize all the buyer requirements in the tech pack. The major parameters tested were GSM of the fabric, quality of seams, uniformity of the stitching, correctness of measurements and the outer look of the garment. The samples were acceptable and a few cases of sleeve alignment were adjusted after acceptance.

QC tests carried out the quality of fabric, proper measure and integrity of seam, which enable buyer's satisfaction and bulk acceptance. Efficient in-process QC minimized rework, minimized defects and allowed an easy transition to bulk production. Problems that were addressed such as puckering and un-matched seam were realized very soon and were sorted out clearly showing that the inline QC actions worked during sampling

4.2. Ball bursting test

Result:

According to ISO 3303-1 Ball Bursting Test knitted rubber or plastic-coated fabric:

- Normal rupturing power: 330.48 N
- Typical extension at break- 89.21 mm
- Max. Bursting strength: 385.63 N
- Minimum bursting strength: 262.37N

The test proved that the fabric was highly elastic and had high burst strength in acceptable ranges to sustainability thus fit to be used where durability is the key application.

Summary:

Ball Bursting Test revealed that the knit fabric is apt against multidirectional force and can be used in T-shirts that need comfort and power. One low extension defect unevenness (22.93 mm) was observed, presumable because of a local defect, which implies bulk inspection. The bursting strength is also high which indicates the stretch ability of the fabric as well as durability of the fabric which is in line with what the buyers want which is quality and long lasting knit products.

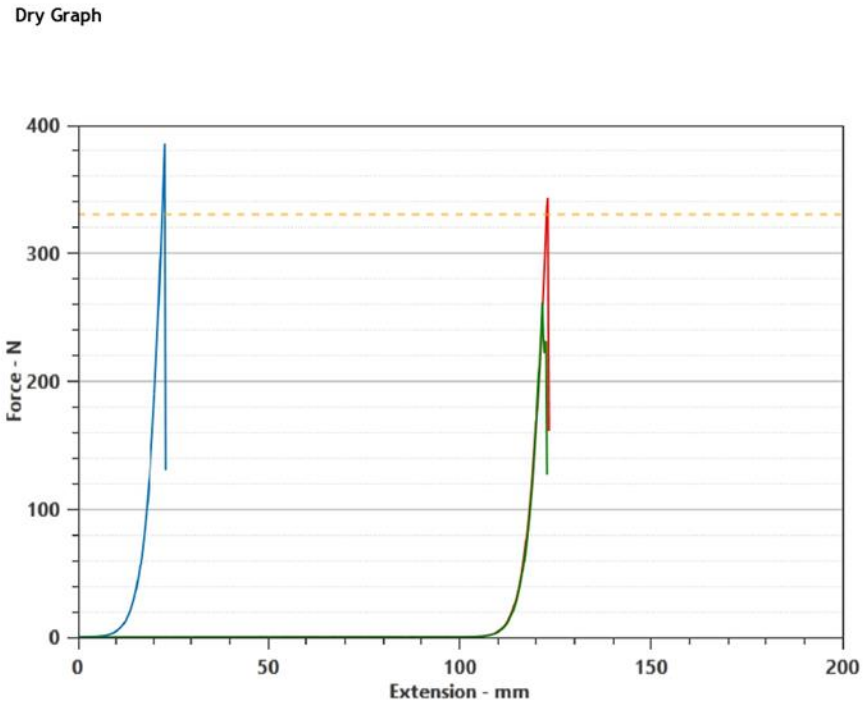


Figure 10 Ball bursting test curve

Table 1.1: Fault of sewing

Issue	Cause	Solution
Neck joint	Rib tack wrong	Right measuring
Shoulder joint	Self-fabric Measurement	Gel tap sewing per inch 10-12 tension
Sleeve joint	Fault sewing	Per inch 10-12 tension
Side sleeve	Side seem	Side sewing match
Sleeve cutting	Wrong cutting	Green line Arm hole joint
Sleeve opening	Wrong cutting	Right thread tension
Side seam	Wrong cutting	Match sewing thread
Hem	Tension stitch wrong	Per inch 10-12 sewing

Table: Derivation of equations to compute and regulate width, WPI, CPI and GSM of circular weft Knit fabric:

Name	Result
WPI (Wales Per Inch)	32
CPI (Courses per Inch)	45
GSM (Gram Per Square Meter)	180
Yarn count	20s

4.3. GSM (Gram per square meter) Test

Result:

GSM of the single jersey knit fabric under test was as follows:

- 180 GSM
- WPI (Wales per Inch) 32
- CPI (Courses per inch): 45
- Yarn Count- 20s

Summary:
The cloth was also tested to satisfy the needs of buyers in the breathable comfort and durable T-shirts. Experimental trials demonstrated the 180 GSM to be weighty enough to be wearable daily and to be structurally stable but did not have any detriment on flexibility. Knitting quality consistency that is essential in even dyeing, printing, and wear resistance was confirmed on the WPI and CPI outcomes. It is necessary to keep GSM within specification to guarantee satisfaction to buyers and reduce shrinkage or deformation following the washing procedure by minor levels.

Appendix A: Tech Pack Format sample

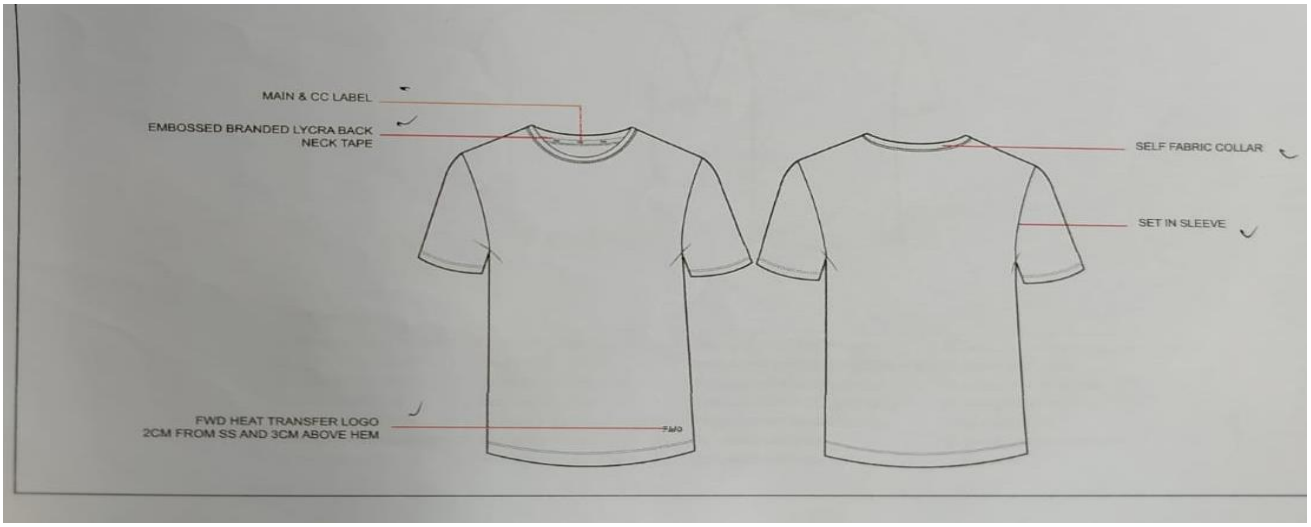


Figure 1.11: Tech_Pack

A tech pack (technical package) was a blueprint written by the buyer and provided to the manufacturer before creation of samples. It includes all the needed significant technical data that helps to prepare the copy of the garment sample. T-shirt

Tech pack may be separated into the following parts:

Style Code and Name of product

- Material (e.g 100 percent Cotton, 180 GSM)
- Color Details (Colour code e.g. Pantone, dyeing method)
- Tolerance Level size Chart
- Point of measurements (POMs)
- Trims @ Accessories Details (Neck ribs, labels, & thread)
- Embroidery/ Printing Placement/ Art Work
- FI (Spirit) / SPI (Stitch Per Inch) / Type of stitching
- Washing Care Information
- FOLDING / PACKAGING instructions

Appendix B: QC Check sheet

Figure 1.12: Ball Bursting Test

The Quality Check Sheet is one of the tools that are being used when carrying out the process of evaluation of the samples so that the buyer is pleased with the parts that are to be taken. It is finished by the QC department and the sample is given to the buyer.

The commonly checked QC parameters are:

- Quality of material and GSM
- Seam age; seam quality
- Measurement of garments (Tech Pack Based)
- Embroidery / Location / Precision Print
- Status Delusion and Label
- Final Quality (The loose threads, stains etc)
- Overall appearance and how it is packaged

Approval Status:

☐ Passed ☐ Rework required ☐ Rejected

An example QC sheet filled in is given.

During the development of T-shirt sample product real time photos were taken by the author and shown below at the selected garment factory

1. Tech Pack review
2. Fabric Inspection
3. Fabric Cutting
4. Sample unit Sewing Line
5. Department of printing and worth
6. Finishing Final pressing
7. Quality Table
8. Tagging and Packing of the Samples
9. Some Picture on the pattern making with GSM and Sample

Appendix C: Buyers Feedback form

Will consist of duplicates of buyer feedback forms received during the process of the carried out case study. These type of forms present inspection of the shape of the t-shirt samples received by the buyer.

Feedback Covers:

- Hand Feel and Look Fabric
- Fit Evaluation (Fit Sample Based)
- Color and Printing accuracy
- Garments Measures
- Recommendations of the changes to be made
- Comment of Rejection or Approval
- Status to Final Approval

Chapter 5: Conclusion.

The research was aimed to examine and facilitate process of developing the samples of T-shirt so that to maximize the satisfaction of the buyers, which is an inseparable part of the process of gaining and maintaining the export orders in the garment industry. The findings indicated that the timely and precise control of the quality development of samples is important in earning confidence of buyer and confirmation of order to it.

When making the study, it was possible to observe that such challenges as miscommunication, the delays related to material sourcing, and the inability to organize the quality assurance process impact the process of sampling negatively. In addition to that, the responses of the buyers underlined requirements of the interpretation of a tech pack and technical correctness of created garments and the need to have qualified employees.

To reduce these factors, it was proposed that besides improved internal communications between the departments, digital tools, more timely selection of the materials, and an increased focus on the quality control aspect even at the lower stages will be used.

In conclusion, it is possible to note that the optimization of the workflow of sample development contributes not only to the increase in efficiency, but to the growth of the levels of buyer confidence and customer satisfaction, which, in their turn, brings about the increase of the levels of business relations and the competitiveness of garment manufactures in the global markets.

References

Ahmed, F. E. (2018). Process, Practices and Techniques- Garment Manufacturing. CRC Press.

Kadolph, S. J. (2015). Textiles (11 th ed.). Pearson Education.

Gandalf Cooklin G., Mcloughlin J. (2012). An Overview of Clothing Manufacture. Blackwell Science.

Mehta, P. V., Bhardwaj, S. K. (2014). Quality Management in Apparel Industry. New Age International.

Razzaque, M. A., 2019. Development, Problems and Opportunities of Bangladesh Readymade Garments Industry. Journal of Bangladesh Textile, 12 (3), 45-53.

D. Tyler, J., & Heeley. (2006). Fashion design sample development: The pre-production process efficiency and precision. International Journal of Fashion Design, Technology and Education 1(1), 15-22.

Flames in fireworks generate mechanical and thermal forces. Thermal forces may result in damages to properties and injuries to individuals. The role of Merchandiser in Sample Development A case study of knit Garments. Journal of Textile Science & Engineering, (7) 2, 123.

Shahid, A., Jamal, T. (2016). The Problem of Quality Control in the Apparel Manufacture: Meaning and Approach. Textile Outlook International 178: 3037.

Rahman, M. S., (2020). Technology: the Process, Tech Pack Management and Sample Approval. Journal fashion technology and textile engineering 8 (4) 101 106.

[Factory Name] interviews and observations carried out between [Month-Year] and [Month-Year] as part of the case study part of this thesis.