

# Minimization of Sewing Defects of an Apparel Industry in Bangladesh with 5S & PDCA

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**Abstract** The readymade garment industry is the leading industry in Bangladesh that's why the Quality improvement of garments can play a vital role. The main purpose of this paper is to reduce the defects that will minimize the rework rate. We worked at "Interstoff Apparels Limited", Bangladesh identifying sewing defects for a particular product (knit T-Shirts). Pareto analysis is performed to identify top defect positions from all the defects and seven are identified where 80% defects occur which should be the major concerning areas to minimize defects percentage. Cause-effect diagrams are constructed to show the root cause, effect, and 5S & PDCA is used to minimize the defects effectively. Recommendations have been added at the end of the study.

**Keywords:** defects, Pareto Analysis, cause-effect, 5S, PDCA, quality, productivity

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## 1. Introduction

As the worldwide economic circumstance changing in a fast motion, typically in an industry extra awareness is given on profit margin, client demand for excessive best product and advanced productivity. In garment production, it is normal that there might be few rejected garments after cargo. Motives are maximum of the manufacturers believed that garments are smooth items and non-repairable disorder may additionally arise due to low first-class uncooked substances or defective technique or worker informal behavior but, factory should have test points to govern over this difficulty. There is no equipped-made solution, which can lessen rejection percentage in a single day. Each order is unique. However, this paper painting suggests the way to cope with such issues and convey down rejection price to minimal with best production. As we see a variety of rejected garment after shipment, maximum of the employer termed those garments as rejected because those garments cannot be repaired via any means. Reworks inside the garments enterprise is a common works that hampers the clean manufacturing price and cognizance negative first-rate products having an effect on standard manufacturing unit financial system. Minimization of reworks is a need to in best and productivity development. Reworks are a vital problem for bad first-rate product and occasional manufacturing charge. Reworks are the non-effective sports that specialize in any interest that consumer are now not willing to pay for. Non efficient sports describe that the consumer does no longer take into account as adding price to his product by using reacting faster in minimization of reworks to make a product as according to purchaser demand with predicted

best, the agency can make investments much less cash and greater prices financial savings. The garment enterprise has performed a leading position inside the development of business sector of Bangladesh. Garment industry of Bangladesh becomes started out within the overdue 1970. Within quick time period, it establishes its recognition all over the global. Now Bangladesh is the leading garment manufacturer and exporter in the global marketplace. In quick, readymade clothes are the main export gadgets in Bangladesh. As the worldwide market is converting swiftly, garment enterprise is extra recognition on better stage of customer pride. They may be giving fundamental focus on customer perceived high best garments and stepped forward productiveness. In garment production, it is standard to peer plenty of garment rejection after cargo. The primary reason at the back of the clothes rejection is that the usage of low best-uncooked cloth such as fabric, thread or faulty system or wrong efficiency of people. Within the production international, marketplace is becoming in high competitive nature. Many agencies have started out to identify and use different strategies to lessen the illness percentage rate. They are taking patron call for on a high priority rate. They understand thoroughly that they will not capable of gain higher patron pleasure until they may now not capable of fulfill client requirements. Therefore, it is important to perceive client demand at the start and then desires to practice the technique to gain the desired results. All business enterprise needs to comply with this approach strictly to reach the vacation spot. In this observe, Pareto analysis is used to become aware of the top defect positions from all the defects from the facts sheet. Then defects are labeled according to their significance. Defects usually end in rejection of clothes, which affect agencies earnings margin deeply. To perceive the basis reason of clothes rejection, cause-impact diagram

is a very useful device. It helps to find, kind and visible show reasons of a disorder problem or first-class function problems. Purpose impact diagram graphically represents the relationship between a given final results and all of the elements that affect the results and subsequently to find out the viable root reasons of the hassle. In this research paper, stitching segment of a garment industry is studied in which produced Knit T-Shirts. Then Pareto chart and purpose effect diagram have been used to discover and classify the reasons, which are answerable for various defects inside the production lines. After that, 5S and Plan Do test action (p.c.) have implemented to lessen the garment defect rate.

## 2. Literature Review

The middle concept behind the tilt is to maximize client fee on the product at the same time as minimizing waste. Lean may be simply defined as developing a greater price for customers by using the usage of fewer sources. A lean business enterprise understands patron value and focuses to fulfill their need with minimal cost. The remaining purpose of lean manufacturing is to provide the choicest cost to the customer thru a perfect fee creation procedure that has 0 wastes. To perform this, implementation of lean is important. Lean thinking changes the point of interest of control for improving productivity from optimizing separate technology, assets, and vertical departments for you to optimize the waft of services and products through entire price streams that flow horizontally throughout technologies, property, and departments to clients. [1]

The lean manufacturing device becomes first added by Krafcik (1988). This effective production device becomes drawn from the famous e-book titled the device that modified the world: The tale of Lean manufacturing (Womack et al., 1990) [2]. Lean production is described as an idea of production machine whereby all production personnel works collectively to do away with waste (Meyers and Stewart, 2002) [3]. Specific systems are used by manufacturers for manufacturing in industries with reducing waste is called lean manufacturing. It is not the philosophy about including most effective few new strategies onto a way to build products but truly changing the way of considering manufacturing (Abdullah, 2003). The impact of lean manufacturing on the cost of production mainly by way of putting off waste has been addressed by means of a number of researchers [4].

Lean manufacturing mainly awareness on waste discount and seven sorts of waste are determined in industries. Overproduction, inventory, Over-processing, movement, ready, Defects, and Transportation are the seven wastes which might be focused with the aid of the lean manufacturing Philosophy (Poppendieck, 2002) [5]. Lean has become a widespread phrase and this machine is utilized to the maximum of the companies. Saleh studied on Iraqi production corporations and located that the manufacturing corporations' opportunities of establishing the tilt structures are special. There is a fine dating among the wondering capital and lean foundations for all of the studied corporations (Saleh, 2011) [6]. In Brazil, The managers of the agricultural equipment zone have supported a transition toward the adoption of lean

production practices. They have got proven a massive improvement in their business overall performance together with the manufacturing fee (Forrester, et.al. 2010) [7].

Lean creation has used in Gaza Strip. It has reduced the steps in the manner. It decreased the complete mission with the aid of 57%, the non-price brought decreased from 81% to fourteen% in the challenge period, and the overall cycle time of the assignment was decreased via 75% (El-Kour, 2009) [8]. A studied has made on distinct nations and has determined that lean production has a big impact on value performance but Lean manufacturing has a widespread impact on cost performance (Hallgren and Olhager, 2009) [9].

After analyzing waste reduction lean gadget it has determined that unneeded processing, transportation of materials and paintings in manner stock wastes and uncooked material inventory was the maximum well-known waste for the manner enterprise sector (Rathi, 2009) [10]. Piercy and richly researched and illustrated that services name facilities for the studied 3 monetary offerings groups can serve the traditionally competing priorities both of operational cost discount and expanded customer support exceptional (Piercy and rich, 2008) [11]. It has been found by means of Czabke, in 2007, that everyone flowers have become extra efficient after imposing lean production in the US and Germany and therefore greater price effective and worthwhile (Czabke, 2007) [12]. Inside the studies, it has discovered that incredible improvements the usage of cost stream mapping in their respective vegetation in both Irish corporations and additionally inside the reduction of all kinds of wastes and inventory (McGrath, 2007) [13]. Every other result of lean production has been reached that it is far a taken into consideration as a strategic device to improve the aggressive function of the employer.

One of the maximum severe wastes is overproduction as it contributes to the opposite six wastes inside the production procedure where manufacturing charges money and there is no cause to provide gadgets that are not demanded (Berg and Ohlsson, 2005) [14]. Koh, et.al. has reached to the conclusion that lower manufacturing charges in any business enterprise, groups are offerings arrange can be achieved when lean manufacturing production practices in that machine are used together with, TQM and JIT (Koh, et.al. 2004) [15]. Stephen (2004) concluded that the gradual charge of company improvement is not because of lack of knowledge of six-sigma or lean. As an alternative, the fault lies in making the transition from theory to implementation [16].

The lean production makes a specialty of efficiency, aiming to produce products and services at the lowest cost and as fast as feasible. Yamashita analyzed for the satisfactory of merchandise and said that better quality products with fewer assets and capital are carried out via imposing lean production and lean manufacturing leads to reductions in value by means of lowering scrap, remodel, returns, and waste from the manufacturing process (Yamashita, 2004) [17]. Lean production device drive and impact on all the activities related to the production process of a company. It has also located that the driving pressure at the back of imposing lean device inside the US changed into the price discount for the steel manufacturing businesses (amongst others) (Abdullah, 2003) [18].

Kilpatrick concluded lean manufacturing in his paper that storing and inventory growing of merchandise cause ever-increasing charges in the form of invested capital, broken completed items, scrapped product, and steeply priced inventory control machine. It also assists to remove all defects is critical to minimize lead-time changed into any other conclusion (Kilpatrick 1997). Joining concluded that on-time transport of products and purchaser delight progressed while lead instances and inventories dropped notably (Joing, 1995). Lean approach is a type of manufacturing method without waste. Waste ("Muda" in Jap) has seven sorts. Those are overproduction, waste of ready time, transportation waste, stock waste, processing waste, waste of motion, and waste from product defects. Despite the huge knowledge, equipment, available resources; many groups are struggling to live "lean" (Shahram, 2007) [19]. Zakaria & Mohamed 2017 has summarized the tilt manufacturing as the maximum convenient way, which cast off unnecessary waste from production and it could offer what customers demand. He implemented lean production for reducing waste from digital assembly line [20].

Root cause analysis is an analytical first-rate checking tool that may be used to perform a corrective and complete process that's based at the evaluation of essential defects Wilson et al. (1993) [21]. In 2005, Canadian Root cause analysis Framework has described that root because evaluation is a crucial element of information and finding the source of defects. Uday A. Dabade and Rahul C. Bhedasgaonkar (2013) analyzed purpose impact diagram in green sand casting system. They have emphasized on casting illness analysis using a layout of Experiments and computer Aided Casting Simulation techniques [22].

Implementation of 5S is the primary stage of lean Implementation for a manufacturing device. Then production environments need to be prepared using 5S. Subsequent the maximum appropriate tools are employed for figuring out the main issues for you to develop a non-stop improvement lifestyle (Pearce & Pons, 2013) [23].

The pursuits of the 5S method are to maintain places of work in exquisite condition thru their garage, organization and cleanliness (Courtois et al., 2007). 5S is taken into consideration as a device that is used to instill non-stop improvement in a sluggish and sequential manner which, with little effort and fee, lets in companies to satisfy various worldwide requirements (Bayo-Moriones et al., 2010) [24]. Utility of 5S in an employer commonly provide the following blessings (Chapman, 2005; Kumar et al., 2006; Gapp et al., 2008): offices emerge as greater efficient, clean, organized, productive and safe; better view of the troubles; development of working situations and values of the employees; expanded productivity, excellent, flexibility, safety and motivation of employees; embodiment of daily sports with the aid of personnel; discount of losses related with disasters and breaks; reduction of fees, unproductive time, area and actions. Kanban device is one of the lean gears by way of imposing that can gain minimal inventory at any one time in the process [25]. It's far a strategic operational choice for using Kanban system to be used in the manufacturing traces. It facilitates to enhance the organization's productivity and on the equal time limit waste in production. Maximum Japanese organizations put into

effect the Kanban machine for its brilliant success in disposing of overproduction, growing flexible workstations, reducing waste and scrap, minimizing the waiting instances and logistics costs; for this reason reducing the inventory stock ranges and overhead costs (Surendra et al., 1999) [26].

Deming in 1950s in Japanese delivered with percentage cycle and different pleasant principles. In addition, they talk about the percentage cycle as the Deming cycle [27]. The simple idea at the back of the percent cycle is to analyze the actual results of an action and examine it with the target or the set factor. It is a repeated and non-stop technique for continuous improvement of the manufacturing. Moreover, the complete repeated technique is represented in the percent (Plan-Do-take a look at-Act) cycle (Basu, 2004) [28]. In 1993, Edwards Deming studied Shewhart cycle, changed it, and called because of the Shewhart Cycle. Its miles a cycle for studying and development or its miles extra recognized layout is the PDSA cycle. Deming described it as a flow diagram for continuous mastering and improvement of a product or a manner (Moen and Norman, 2010) [29].

From this, it is miles without difficulty comprehensible those implementations of lean manufacturing in any organizing identifies and get rid of waste and reduce the price.

### 3. Background of the Study

Readymade garment industry is highly depends on several factors such as quality of the product, manufacturing lead time, production cost, quality of the available raw materials, workers efficiency, production managers supervision etc. Various product defects hamper these factors. In garments factory, repairable defects leads to rework and non-repairable defects leads to rejection. To minimize the rework rate, factory personnel needs to keep his eyes on defect rates from the beginning. When rework and rejection occur, a company loses profit margins, negative impact on production schedule, huge possibility to cancel the order from the buyer and increasing interest rate of bank loan. In short, rework rate create negative impact on production rate and rejection cause loses of huge profit margin for the company. To be powerful in defects and rejection reduction, it is essential to establish and keep clear, complete and modern-day written information of inspection and check processes for each operation. Those facts should identify standards for popularity/rejection. Inside the apparel production industry, main uncooked cloth is material; others are extraordinary kinds of trimming and add-ons. Operational wastages in the clothing production system are top surface transform, printed label remodel, sewing defects, pinhole rework, cloth defects, wrong fly shape, and different reworks. To gain the general goal in minimizing defects and rejection of completed merchandise it's miles needed to set up document and keep a machine capable of ensuring that products conform in overall to requirements specifications. This will be required at each level of manufacture. Records have to be maintained to offer goal evidence that the required requirements have been met. Additionally need to employ a control representative

preferably unbiased of other functions to be accountable to oversee the overall manipulate gadget and inspection at every level of manufacture. The person appointed have to have the vital authority to execute any action associated with accomplishing the preferred popular of product. To be powerful the system requires planned periodic overview by means of senior management to ensure that its effectiveness is maintained.

## 4. Research Methodology

Methodology means the procedures to obtain the result. For this study, we have conducted the following procedures to minimize the defects. Steps involved in the study-

### Step 1: Factory Selection

After gathering information, we have selected a factory, which is situated in Kaliakoir, Gazipur, Dhaka.

### Step 2: Conducting a Case Study

Finally, we conduct our research work in a particular garment factory named "Interstoff Apparels Limited". The demography of the situated organization is presented in Table 1.

Table 1. Demography of "InterstoffApparels Limited"

Company Name	InterstoffApparels Limited
Location	Kaliakoir, Gazipur, Dhaka
Product Type	Knit/Woven Garments
Total Number of Worker	Male: 1850   Female: 650 Total : 2500
Production Capacity	1200000 PCS/YEAR
Working Hour Per Day	10 Hours (Maximum)

### Step 3: Gathering Information

In this step, we have gathered information of the sewing defects section of the selected garment factory. Here we have collected data on various sewing defects provided by the management, which is used for the Analysis purpose of the study.

### Step 4: Identification of Problems

Identifying the problem is the major concern for this study. From our observation, we have seen repetitive defects occur in the sewing section. Therefore, we tried to do our research work on this section, which is our major concern.

### Step 5: Analysis and Suggestions

In this step, Pareto Analysis is performed which is required to identify major concerning areas. After that, Cause-Effect Diagrams have been constructed for top finishing defect types. Then we have provided some respective suggestions to minimize the frequency of those defects. Figure 1 shows the methodology.

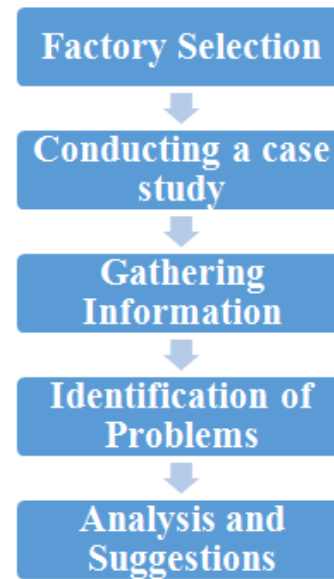


Figure 1. Methodology

## 5. Findings & Data Analysis

For findings and data analysis, we have collected data from the selected factory "Interstoff Apparels Limited" for the months April 2017. Table 2 shows the summary of defects April 2017.

Table 2. Summary of defects April 2017

No	Name of the Defects	Total number of Defects
1.	Broken stitch	8116
2.	Loose tension	714
3.	Hem Length Up down	35
4.	Dirty Spot	79
5.	Down Stitch	2282
6.	Join Stitch	1496
7.	Label missing	663
8.	Needle mark	42
9.	Oil Spot	167
10.	Open seam	5120
11.	Part shading	210
12.	Pleat	4532
13.	Point up down	2770
14.	Print defect	98
15.	Puckering	1008
16.	Tack missing	2189
17.	Skip stitch	5488
18.	Sldr up down	105
19.	Without button	217
20.	Un trims thread	2231
21.	Other	8785

### 5.1. Pareto Analysis

From the above data, we have performed Pareto analysis. Pareto analysis shows the top defect positions.

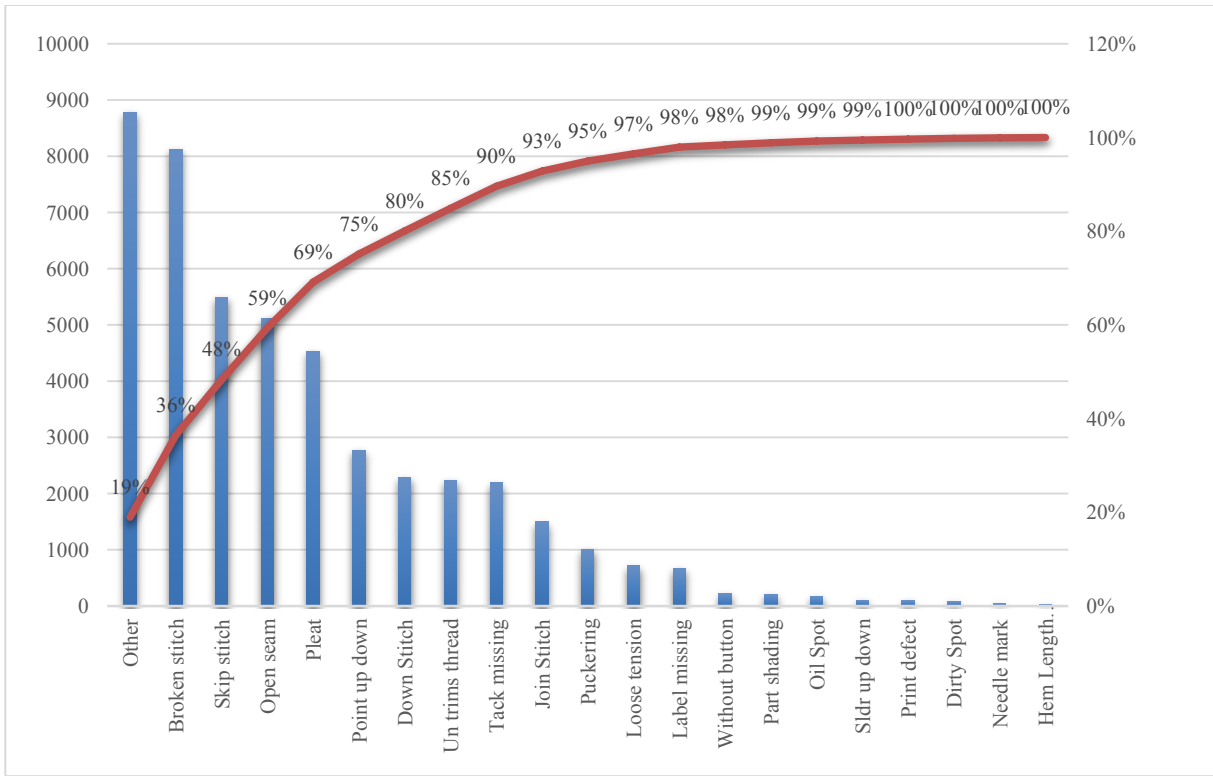


Figure 2. Pareto analysis of the defects

**Observations from Pareto Analysis for Top Defect Positions**

1. Other is the most frequent defect with as much as 19% of the total.
2. Broken stitch is the second most frequent defect with 17% of the total. Also, skip stitch 12%, Open seam 11%, Pleat 10%, Point up down 6%, down stitch 5% is other defect of the total.
3. So, broken stitch, skip stitch is the “Vital Few”.

**5.2. Cause Effect Diagram**

Cause effect diagram for broken stitch:

From the Pareto chart, it is clear that broken stitch is a major type of defect in the sewing section. Broken stitch is created and increasing defects for the tendency of producing more and garment become tampered. The reporter has identified the major causes, which are responsible for man, machine materials, and methods. The cause-effect diagram for broken stitch as shown in below:

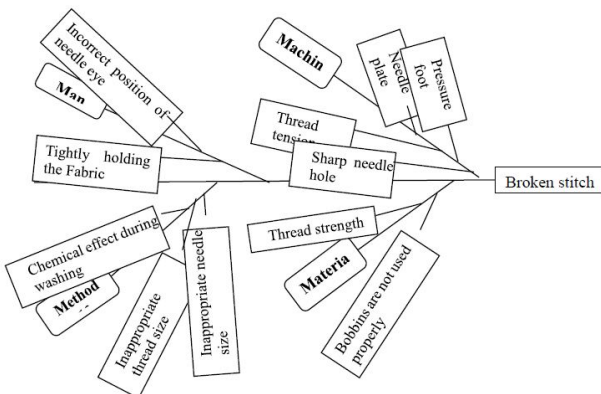


Figure 3. Cause effect diagram for broken stitch

For solving this problem and reducing broken stitch, the tension of the thread needs to properly adjust. Inspection of the needlepoint at regular intervals and checking for sharp or burred points are required. Sharp edges of needle plate, the pressure foot, and needle holes may have sharp edges, which should be removed. Needle size and thread size should be synchronized. Special care of the product should be taken during washing. Materials weak thread is Selecting good quality thread which is free from flaws.

Cause effect diagram for skip stitch:

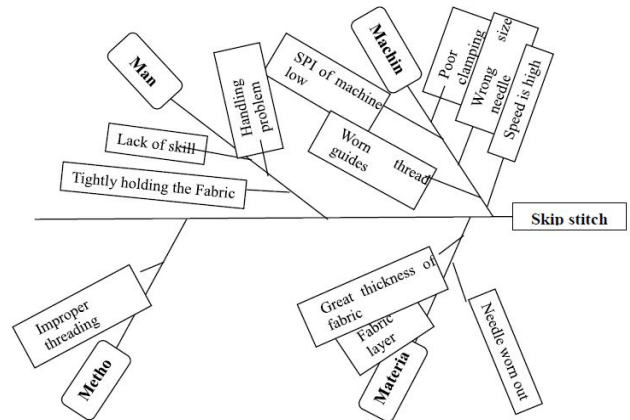


Figure 4. Cause effect diagram for skip stitch

Skip stitch is another major defect for garments. This can be caused by rough handling of materials. For solving this operator should carefully handle the material during operation. Stitch per inch (SPI) of the machine may cause for slipstitch. Appropriate maintenance to keep the machine in good working condition should be taken to get the continuous stitch. Needle worn out can also create skip stitch, which can be solved by replacing the needle.

Cause effect diagram for open seam stitch:

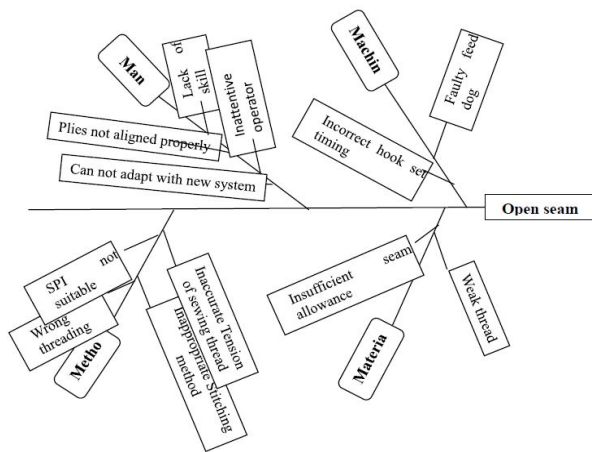


Figure 5. Cause effect diagram for open seam stitch

Lack skilled operators are responsible for open seam defects. A well-skilled operator who knows very well how to handle the materials. A standard operation video can be shown to the operator. Faulty feed dog can create an open seam, so these should be checked periodically.

Cause effect diagram for down stitch:

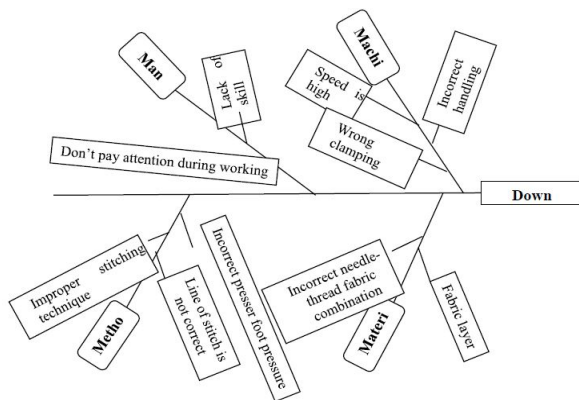


Figure 6. Cause effect diagram for down stitch

The main causes for occurring down stitch is lack of proper training to the operators and making the skilled operators. Wrong calming and incorrect material handling can create seam away from the right place. So clamp should be attached accurately. Needle-thread-fabric combination should match correctly in order to reduce down stitch defects.

5.3. Application of 5S

5.4. Application of PDCA

The theory of the PDCA cycle process was promoted by ISO 9001:2000, which systematically identifies and manages the processes that combine the quality systems and the interactions between the processes. This process is explained as Plan-Do-Check-Action cycle (PDCA). This method applies to all processes to control the production quality. For implementing PDCA cycle, initially, it is required finding the opportunity. The defect percentages are calculated in the following table where PDCA will be applied to reduce and eliminate waste:

Table 3. Application of 5S (Table shows the application of 5S.)

Category	Item
Sort	Remove what is not needed and keep what is needed.
	Waste materials on the floor, corner area.
	Fabric kept on the floor in wrong ways.
	Low skilled worker.
	Which worker violates “clean” conduct.
Set In Order	Arrange essential items in order for easy access.
	Garments are not arranged. Operators are not maintaining work flow.
Shine	Keep things clean and tidy.
	Machines are not properly cleaned.
	Floors, walls and stairs are not properly cleaned. Operator hands are not cleaned properly.

Table 4. Summary of defects with defect percentage April 2017

No	Defect Name	Total Defects	% of defects
1.	Broken stitch	8116	17.51
2.	Loose tension	714	1.54
3.	Hem Length Up down	35	0.08
4.	Dirty Spot	79	0.17
5.	Down Stitch	2282	4.9
6.	Join Stitch	1496	3.22
7.	Label missing	663	1.4
8.	Needle mark	42	0.09
9.	Oil Spot	167	0.36
10.	Open seam	5120	11.04
11.	Part shading	210	0.45
12.	Pleat	4532	9.77
13.	Point up down	2770	5.98
14.	Print defect	98	0.21
15.	Puckering	1008	2.17
16.	Tack missing	2189	4.72
17.	Skip stitch	5488	11.84
18.	Sldr up down	105	0.23
19.	Without button	217	0.47
20.	Un trims thread	2231	4.81
21.	Other	8785	18.95

The pie chart shows the percentage of defects cover by each type of defect:

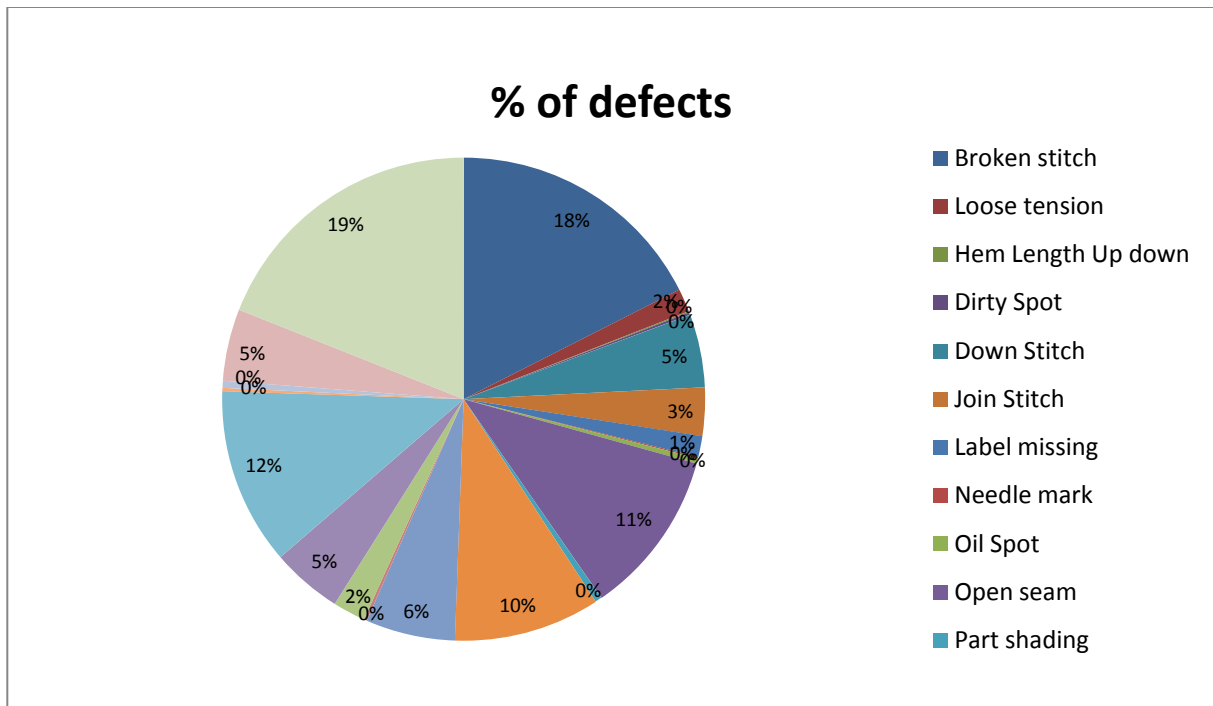


Figure 7. Percentage of defects covered by each type of defect

Here, it has been found that the most defects happen at broken stitch, skip stitch, and open seam and pleat. In addition, their percentage is 17.51%, 11.84%, 11.04%, 9.77%. After analysis those defects, below causes are identified:-

## 6. Recommended Suggestions to Reduce Defects and Reworks in Sewing Section

A manufacturer stays in commercial enterprise only as long as his product best satisfies his clients at the rate they are prepared to pay. Failure to maintain an adequate first-class preferred can, therefore, is disastrous. However, the inspiration endorsed to stitching phase of clothing enterprise to limit defects and reworks are highlighted here put together garment description with comic strip/photograph. Strictly have to follow the pattern garment properties. At some stage in a working method inside the stitching line, three high-quality controllers at in-line and quality controllers at output desk are strongly cautioned to become aware of the causes and consequences and to provide the right answer. Statistics of checklist for inspection of add-ons and packing cloth, data of swatch cards of authorized accessories, data of manufacturing swatch, statistics of everyday quality control document, facts of slicing hassle record, records of inspection file all through embroidery as well as others all information need to be accompanied nicely. Record seams and stitches for garment assembly measure all applicable seam houses e.g. stitches according to cm, extensibility, seam electricity. Determine on the collection of assembly operations, determine on seams and threads to be used and test system availability, keep in mind alternatives if machines are not available. Take a look at of completed garment. Have a look at for look and compare with cartoon/picture. Take look at all technical aspects of any material faults, sewing thread, seaming faults, and many others. File all faults discovered at final inspection for fast correction and to discover the need for preventative action at a precise level of production. Those hints have been recommended to the man or woman department.

Table 5. Cause identification using PDCA and WH questions

	5 WH Questions:	Answers of the 5 WH Questions:
<b>PLAN</b>	Q (1): What is needed to be done? Q (2): How much is needed to be done? Q (3): Where it is needed to be done? Q (4): Who should do it? Q (5): When it is needed to be done?	A (1): Perfect stitching is needed. A (2): Goal is to reach zero defects. A (3): In every stitch on seam line. A (4): The Operator should do it. A (5): It is needed to be done during Sewing.
<b>DO</b>	<b>Process implementation according to PLAN:</b> Install, adjust and use the machine properly. Using a good needle, quality-sewing thread and supported equipments. Recruit expert operator. Spend proper time for each operation.	
<b>CHECK</b>	<b>Inspection of the process:</b> Planned monitoring and measure the process and the products. Check if the defects are reduced or not? If the defects are not occurring or reducing then continue the action of the process successfully. If defects are occurring, then go back to the PLAN stage and develop some more ideas for solving and reducing defects and go through the cycle again.	
<b>ACTION</b>	Take action on the accurate process for continually improving process performance. If any defects are found, then start the PLAN stage for solving it.	

## 7. Conclusion

Quality is the most important question for customer satisfaction. Not only in apparel manufacturing industries but also in any production; Good quality increases customer satisfaction through increasing the value of the product, it establishes brand or company name, and builds up a good relationship with the exporter, which in turn results into high volume sales and higher profit.

The defects in apparel industries are one type of major loss or minimize the profit. The first concern for any manufacturer should be to produce and deliver quality products at the right time. However, defects in product usually lead to reject, rework, time-consuming, extra working time and customer dissatisfaction. In order to solve all of this problems and minimizing waste, lean tools are applied in apparel industries.

This paper has analyzed the garment sewing defects using lean tools: Pareto chart, cause-effect diagram, 5S implementation, PDCA cycle for minimizing defects and resulting increasing quality and making more profit.

The Pareto chart shows that the major cumulative defects are others (19%), broken stitch (36%), slip stitch (48%), the open seam (59%) etc. From this chart, we can easily find the most important defects and then we can use the cause-effect diagram for finding the major causes for that defect. After taking the corrective action for the causes identified in the cause-effect diagram, we use 5S lean tool for minimizing defects. Finally, the PDCA cycle helps to plan for continuously improving the quality by removing defects, perform on the process based on the plan and next checking and monitoring the process that it is going through the right procedures. Finally, corrective is taken for further improvement.

This study helps to minimize the defects of sewing for any apparel industries.

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