Analysis of Major Defects Position and Percentage in Sewing Lines of a Garments Factory with the Help of Pareto Chart, Cause Effect Diagram and Sigma Level

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Abstract— Bangladesh is a developing country and 83% of the foreign currency comes from the garment sector. Garment export business is a vital issue for our country. To upgrade the position in the ranking and to make the position strong in the world contest we have to compete with world class competitors by maintaining 100% quality. So, we have to ensure that our production process management systems are the best and always under development and also capable of producing best quality product. This project work represents a study on defects in the sewing lines of a garments factory by Pareto chart, cause effect diagram and six sigma to find out the major defects and their percentage and also find out the defect standard level with the help of total amount of defects per million garments. It is studied in "Comfit Composite Knit Limited" which is a 100% export oriented knit garment factory. We worked in the sewing section for our project purpose and collected three months total defects data with all sewing lines, analyzed the defects by Pareto chart and identified 7 major defect positions where 78.94% of total defects occur. After that we worked in separate line to find out the defect condition. We observed in case of short sleeve polo shirt and sweat top tee sewing defects. After Pareto analysis, it was found out 9 major defects which contain 11.86% defect position areas where 54.02% of defects occur in case of polo shirt and in case of sweat top tee 5 major defects which contain 11.29% defect position area where 53.31% of defects occur, it was analyzed 6 common major defects and causes of these defects. Then it was shown by cause effect diagram and given some recommended remedies for these causes. After analysis the defects by sigma calculator we got sigma level 2.78 for all production lines, sigma level 2.88 for short sleeve polo shirt production line and sigma level 2.75 for sweat top tee production line which were inside the standard defect range.

Index Terms—Cause Effect Analysis, Defects, DPMO, Pareto Chart, Quality, Rework, Sigma Calculator.

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1 INTRODUCTION

The garments industry has played a vital role in developing the socio economic condition in Bangladesh [1] [2]. Despite of its modest beginning in 1970s the apparel industry in Bangladesh has grown to become one of the largest contributors to the export revenue of the country representing its total exports [1]. Moreover the apparel industry also contributes around 83% of country's export earnings of Bangladesh. Being the single largest employer in the manufacturing sector, the apparel industry provides at least 20 million of Bangladeshi's employment directly as well as indirectly. The quality of garments is vital to its survival in an increasingly competitive apparel industry in order to maintain the production of high quality garments and improved productivity in the apparel industry [3] [5].

As the world economic condition is changing in a rapid motion. Generally in an industry more focus is given on profit margin, customer demand for high quality product and improved productivity. In garment manufacturing, it is usual

that there will the few rejected garments after shipment. Reasons are most of the manufacturers believed that garments are soft goods and non-repairable defect may occur due to low quality raw materials or faulty process or employee casual behavior. There is no ready-made solution that can reduce defect percentage overnight [4] [5].

But this paper work suggests how to handle such problems and bring down defects rate to minimum with quality production. As we see a lot of defective garments after shipment, most of the organization termed these garments as rejected because those garments can't be repaired by any means [7]. Defect in the garments industry is a common phenomenon that hampers the smooth production rate and focus on poor quality products having an impact on overall factory economy. Minimization of defects is a must in quality and productivity improvement. Rework is a vital issue for poor quality product and low production rate [13]. Reworks are the non-productive activities focusing on any activity that customers are not willing to pay for. Non productive activities describe that the customers does not consider as adding value to his product. By reacting quicker in minimization of reworks to make a product as per customer demand with expected quality, the company can invest less money and more costs savings [3][6]. Therefore, a study was carried out in the garment industry named "Comfit Composite Knit Limited" in sewing section to identify defects so as to eliminate them for saving time, cost and improved product quality.

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2 MATERIALS AND METHODS

2.1 Materials

1) Fabric Cut panel. 2) Sewing Thread. 3) Filament Thread. 4) Button. 5) Interlining. 6) Short Sleeve Polo Shirt. 7) Sweat Top Tee. 8) Sigma Calculator.

2.2 Methods

The quality tools which are used in this project are aimed at identifying analyzing and implementing the defects in the sewing line. Though defects are occurred in various departments in a garment factory, but we have concentrated only in the sewing line. Quality is a main issue of a garment factory. So we have to concentrate on defects. Defects can occur for various reasons. Because of this defects rework time and cost increases. This study includes theatrical idea about sewing line layout, various defects, defect occurring position, Pareto chart, cause-effect diagram, sigma level defects per million opportunities. For this research we have selected a 100% export oriented knitting garments factory named "Comfit Composite Knit Limited". This segment includes understanding about the quality control system and how they perform when defects occur and analysis the various data. Then analyzing the data we have gathered idea about the defects and try to find a solution how to minimize the defects. Last of all we have tried to implement to reduce defect percentage. The methodology steps are given below:

Step 1: Factory Selection

For our research work first we have to select a factory from where we have to collect data. After a lot of searching we have been allowed by a 100% export oriented factory which is situated at Mirzapur, Dhaka.

Step 2: Data Collection

After selecting the factory we have selected the sewing department for our project. We have observed the quality control system of the department. We have collected various defects data for the month of August 2015 to October 2015 with 12 production lines for our project. This data is obtained by QC man by 100% inspection in the end line QC. We also collected the total garments checked in that time.

Step 3: Analysis Data

In this Step, we've to analyze the collected data to know about the defects amount and percentage of defects. We have to calculate the wise total defect data and three months total defects data Men we've to analysis separate production line defects for SS Polo Shirt and Sweat Top Tee.

Step 4: Analysis Data by Parero Chart & Cause Effect Diagram
In this step, we've to analyze the defect data by pareto chart tor to identify the major defects that occurs 80% area. From the chart we have to find the defect position where the most de-

fects occur. Then we've to analyze major defects by cause-effect diagram to identify the causes and sub-causes. Also to identify for which masons the major defects occur i.e. man, machine, material and method.

Step 5: Analysis Data by Sigma level

In this step, we've to analyze the total defects and the total checked garments by sigma calculator to know the about the defect standardization i.e. the sigma level and defogs per million opportunity.

Step 6: Some Suggestions for Implementation

In this step, we've given some suggestion how to minimize the defects that occurred in the sewing lines.

3. RESULTS AND DISCUSSION

3.1 Data Analysis and Observation by Pareto Chart
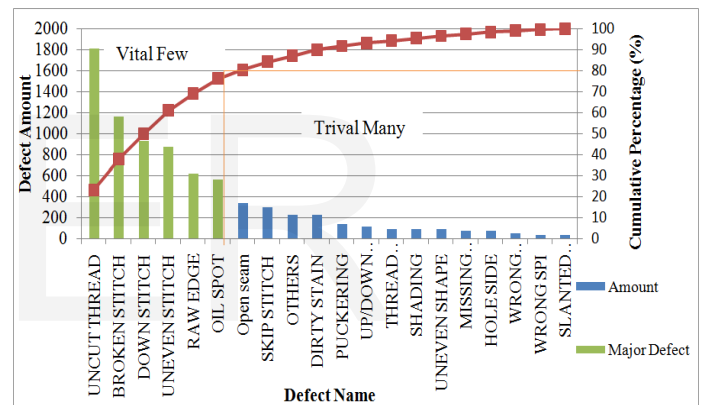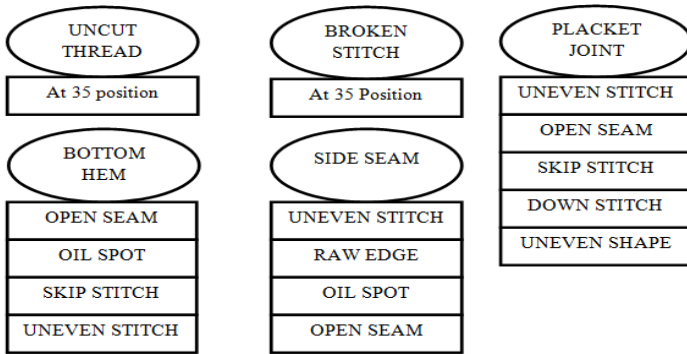
3.1.1 Three Months Defect Chart for SS Polo Shirt

Figure 1: Three Months Defect Chart for SS Polo Shirt

3.1.2 Observations from the Analysis

i. UNCUT THREAD is the most frequent defect with as much as 23.16% of the total defects of SS Polo,

ii. BROKEN STITCH is the second most frequent defect with 14.86% of the total.

iii. Among other defects contribution of DOWN STITCH is 11.87%, UNEVEN STITCH is 11.22%, RAW EDGE is 7.86%, and OIL SPOT is 7.2%.

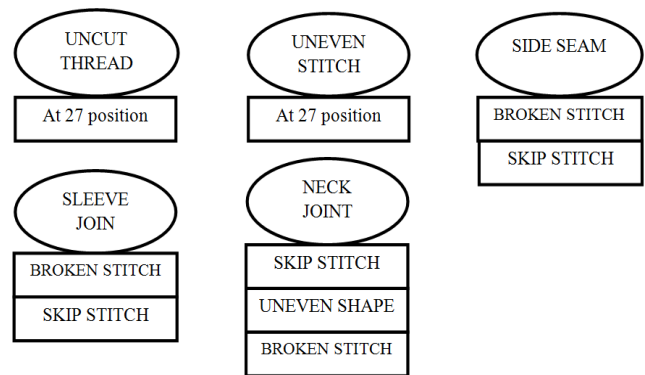iv. These six major defects are the "vital few" where 76.17% of total defects occur.

Now we have analysis defects by SS Polo Shirt part wise. For this, we are using side seam, bottom hem and placket joint defects data.

3.1.3 Major Concern Area foe SS Polo Shirt

Total Defects Position = 35+35+4+4+5 = 83
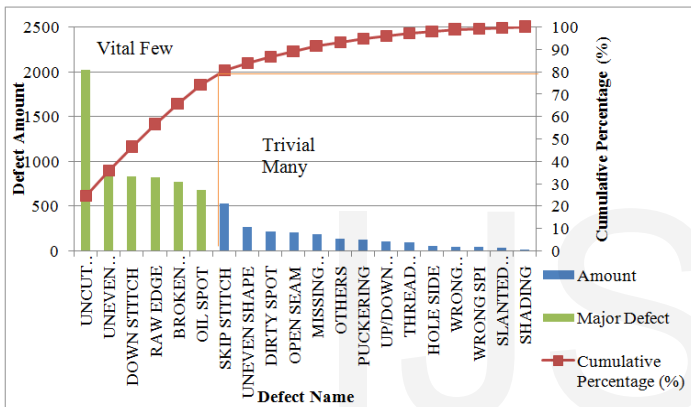
3.1.4 Three Months Defect Chart for Top Tee

Figure 2: Three Months Defect Chart for Top Tee

3.1.5 Observations from the Analysis

i. UNCUT THREAD is the most frequent defect with as much as 24.88% of the total defects of Sweat Top Tee,

ii. UNEVEN STITCH is the second most frequent defect with 11.28% of the total.

iii. Among other defects contribution of DOWN STITCH is 10.20%, RAW EDGE is 10.12%, BROKEN STITCH is 9.5% and OIL SPOT is 8.33%,

iv. These six major defects are the "vital few" where 74.31% of total defects occur.

  Now we have analysis defects by Sweat Top Tee part wise. For this, we are using side seam, shoulder joint and neck joint defects data.

3.1.6 Major Concern Area foe Sweat Top Tee

Total Defects Position = 27+27+2+2+3 = 61

3.1.7 Result of Pareto Chart

Total Number of Defects = 8150
Total Number of Defects in Major Concerning Area = 4345
Percentage of defects in major concerning area,
 = 4345/8150
 = 0.5331 X 100%
= 53.31%
There are 20 types of defects where uncut thread and uneven stitch can occur at 27 positions. Rest 18 types of defects can occur at 27 positions.

So, the number of total concerning area is [27+27+ (18×27)] = 540 which is responsible for total amount of defects.

But we have identified total 61 concerning areas by Pareto Analysis which is responsible for 53.31% defects.
Total number of concerning area = 540
Total number of major concerning area = 61

Percentage of major concerning area,
= 61/540
=0.1129 X 100%
= 11.29%
So by concentrating only on 11.29% areas 53.31%of total defects can be reduced.

3.1.8 Defect Percentage of Two Production Lines

Total Defects Occurred by 12 Production Lines = 98240
Total Defects Occurred by SS Polo Shirt Production Line = 7811
Total Defects Occurred by Sweat Top Tee Production Line = 8150
Two Lines Combined Total Defects = 7811+8150 = 15961

Defect percentage of Two Production Line,
 = 15961/98240
= 16.24% of total defects percentage.

3.2 Major Defects Analysis by Cause-Effect Diagram and Recommended Remedies

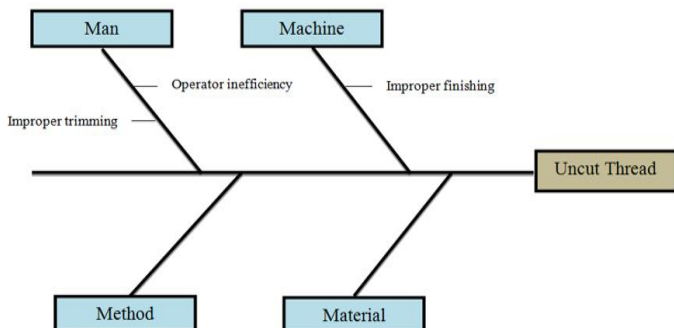### 3.2.1 Cause-Effect Diagram for Uncut Thread

Figure 3: Cause-Effect Diagram for Thread Uncut

Table 1: Cause-Effect Diagram for Uncut Thread

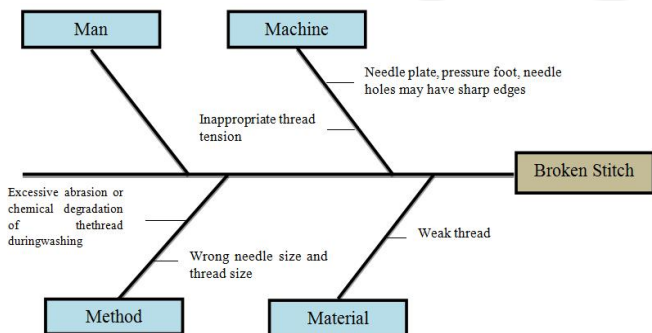| Causes	Suggested Solutions
Operator inefficiency	Provide adequate training to the operators
Improper trimming	Provide thread cutter to every operator and make used to.
Improper finishing	Improve quality inspection system.

3.2.2 Cause-Effect Diagram for Broken Stitch

Figure 4: Cause-Effect Diagram for Broken Stitch

Table 2: Cause-Effect Diagram for Broken Stitch

Causes	Suggested Solutions
Inappropriate thread tension	Tension of the thread properly adjusted.
Needle plate, pressure foot, needle holes may have sharp edges	Inspect the needle point at regular intervals and check for sharp or burred points.
Weak thread	Select good quality thread which is free from flaws.

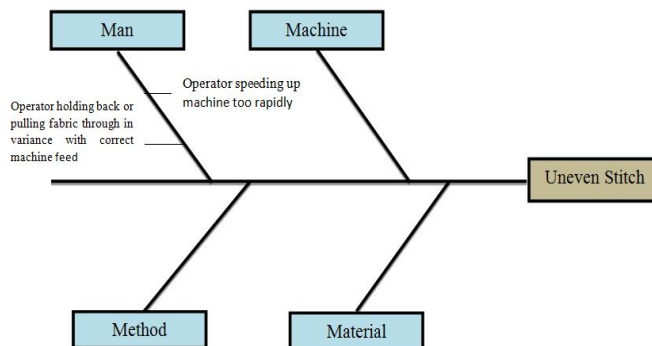| Wrong needle size and thread size	Needle size and thread size should be synchronized.
Excessive abrasion or chemical degradation of thread during washing	Special care should be taken during washing.

3.2.3 Cause-Effect Diagram for Uneven Stitch

Figure 5: Cause-Effect Diagram for Uneven

Table 3: Cause-Effect Diagram for Uneven

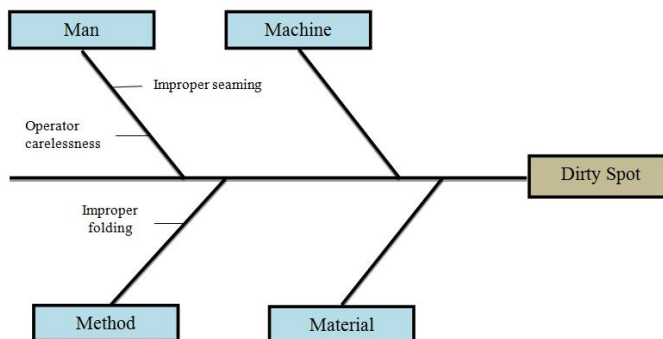| Causes	Suggested Solutions
Operator speeding up machine too rapidly	Control the speed of machine, use right needle and correct feed control.
Operator holding back or pulling fabric through in variance with correct machine feed	Improve the skill of operator, use good quality sewing thread, and provide standard quality specification.
	Never pull on the fabric while sewing, let it be taken up by the machine.

3.2.4 Cause-Effect Diagram for Raw Edge

Figure 6: Cause-Effect Diagram for Raw Edge

Table 4: Cause-Effect Diagram for Raw Edge

Causes	Suggested Solutions
Improper seaming	Give proper training to the operators.
Operator carelessness	Improve supervision.
Improper folding	Improve or change folding system.

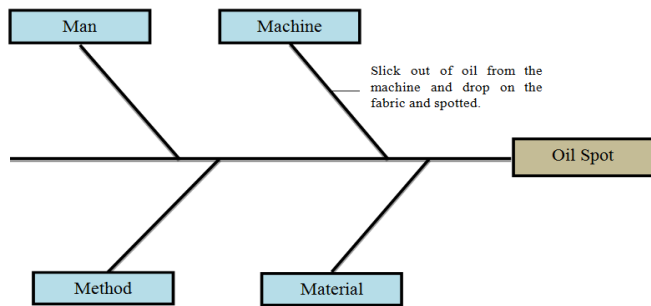### 3.2.5 Cause-Effect Diagram for Oil Spot

Figure 7: Cause-Effect Diagram for Oil Spot

Table 5: Cause-Effect Diagram for Oil Spot

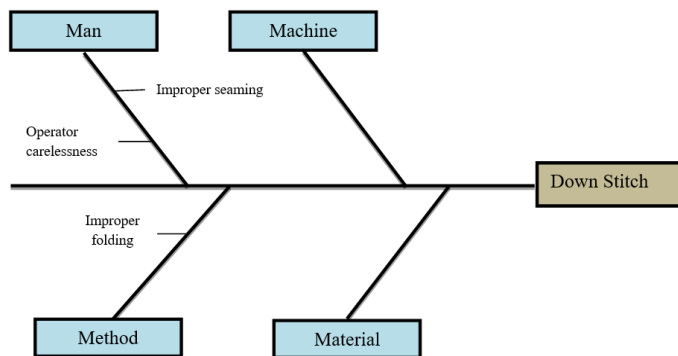| Causes	Suggested Solutions
Slick out of oil from the machine and drop on the fabric and spotted.	Check the sewing machine regularly.

3.2.6 Cause-Effect Diagram for Down Stitch

Figure 7: Cause-Effect Diagram for Down Stitch

Table 4: Cause-Effect Diagram for Down Stitch

Causes	Suggested Solutions
Improper seaming	Give proper training to the operators.
Operator carelessness	Improve supervision.
Improper folding	Improve or change folding system.

3.3 DPMO and Sigma Level Analysis

For this analysis, we have used sigma software calculator. If we give input the total garments checked amount, no. of defects amount, opportunity/unit and standard sigma shift then we find the defects percentage (%), defects per million opportunities (DPMO) and sigma level.
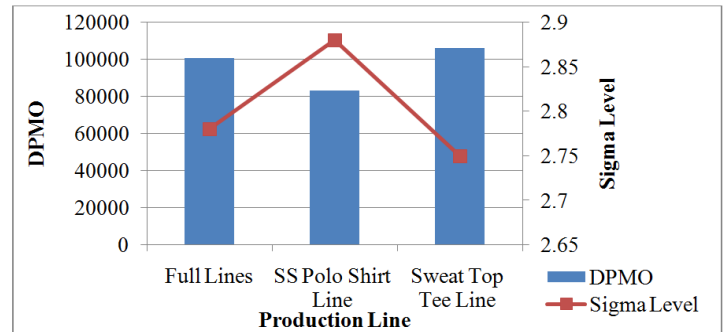

Figure 8: DPMO and Sigma Level Analysis

3.3.1 Observation

From the analysis, we find that defects level lies between the 2 to 3 sigma levels. So Defect Standard of this factory is medium quality. Here Sigma Level of full Production Lines is 2.78, SS Polo Shirt Production Line is 2.88, and Sweat Top Tee Production Line is 2.75.

From the Bar-line graph chart we understand that in SS Polo Shirt Production Line the DPMO decreases, so the Sigma Level increases. That means the defects occurred in this line is less.

3.4 Results

For Pareto Chart Analysis
- From the three months combined defect chart with full production line we find 7 major defects which contains 78.94% of total defects.
- From the SS Polo Shirt Production line we find 9 major defects which contain 11.86% defect position area where 54.02% of major defects occur.
- From the Sweat Top Tee Production line we find 5 major defects which contain 11.29% defect position area where 53.31% of major defects occur.

For Sigma Level Analysis
- For full production line, we find sigma level 2.78.
- For SS Polo Shirt Production line, we find sigma level 2.88.
- For Sweat Top Tee Production line, we find sigma level 2.75.

4   CONCLUSION

Quality is a serious issue for an export oriented garment's factory. In order to take a strong position in the global competition, it is necessary to keep 100% quality on the product. Now-

a- days, buyers are more concern on quality. If any fault is found, they will have to cancel the full order. So, it is a great responsibility for a quality department in a garment factory. In this view, we are tried to analysis the quality condition in the "Comfit Composite Knit Limited". Garments factory has many departments, so a short time we are not able to observe the all departments. So, we concentrate on sewing department only. Here we have studied on the defects and tried to find out the major defects with their concerned area. We have used Pareto chart to find out the major defects by 80/20 rules. Then we have found the defect position where the major defects occurred. From this analysis, we find 6 common major defects which are occurred in all the production lines. After that we have used sigma calculator to find out DPMO and Sigma level. From this we have easily understood the defect conditions of the sewing lines of this factory. Then we have used the cause-effect diagram to find out the causes and sub-causes which are responsible for major defects. But it is our great lacking that we are not able to implement anything in the sewing line because of production load. But we have suggested some suggestions to the QC manager. If our suggestions are applied on the lines, we hopeful that the defect percentage, rework cost and time will decrease and the productivity will increase.

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