

# **Assessing Performance and Improving Productivity Through Identification of Sewing Defects: A Multi Criteria Based Case Study in an Apparel Firm in Bangladesh**

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## **Abstract**

The apparel industry of Bangladesh has been the leading export division and the preeminent source of foreign exchange. However, these industries are still confronting obstacles such as insufficient productivity, poor quality, higher defects rate which is reducing its output to a significant extent. Minimization of defects by identifying the causes in various sections of these industries can significantly improve its productivity. This study emphasizes on identifying the root causes of sewing defects in an apparel firm and proposed auspicious corrective actions to reduce these defects. This study is carried out at Fakir Apparels Limited to minimize the defects rate in its sewing section. Pareto analysis has been performed to identify the most significant one among all the defects in two production lines and root causes of these defects have been analyzed by the cause-effect diagram. Moreover, a Plan-Do-Check-Act (PDCA) Cycle has been designed to establish the corrective actions based on the root cause analysis. Finally, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), a multi criteria decision making (MCDM) technique has been used to rank and recommend different managerial decisions based on their priority and impact. The outcome of this study may bring significant changes in the sewing section of the apparel firm in terms of productivity and effectiveness.

## **Keywords**

Productivity, MCDM, TOPSIS, Cause-effect analysis, PDCA.

## **1. Introduction**

There have been many improvements in international trade agreements for apparel products over the last decade, creating new challenges and opportunities for Bangladesh's export-oriented apparel industry. Moreover, many domestic challenges are also prevalent. Ready-made Apparel is one of the sections of the garments sector's pack at present. On the contrary, without the sewing process, the ready-made garment is totally incomplete. But it is true that, in this part, we often do not get the expected outcome. It is due to lack of proper ability, process disruption and inappropriate adjustment of the machine. Fault has occurred due to these obscurities and impacts on consistency, productivity, cost and even production. Minimization of rework is mostly important for reducing scrap, rework and additional processing. Quality requirements are also part of a company's normal operating,

product creation and production planning process. Standards represent the overall intrinsic level of quality that the organization aims to attain. The basic aim of using the quality standard is to maintain continuity between the product line.

A widespread phenomenon that hampers the smooth production rate and focuses on low quality goods with an effect on the overall factory economy is a defect in the garment industry. In terms of quality and efficiency growth, minimization of defects is a must. For poor quality goods and low production rates, rework is a critical problem. Reworks are non-productive tasks that concentrate on any task that clients are not prepared to pay for. Non-productive practices define the fact that the consumer does not perceive his product as adding value. The business will spend less capital and more cost savings by responding faster in reducing reworks to make a product with expected quality as per customer demand.

It is mandatory to locate the fault and find the best way to reduce the error due to preserving norm or product quality. In the analysis, the product control chart was used within the process control list. The goal of "Defect Detection" is to locate the cause of the defect and the imminent means of uncovering faults in real time.

The sewing section defect has a great correlation between quality and productivity. If more defects are found after stitching, then the cost of the product is adversely affected. Before other operations obstruct seam removal and re stitching, there is a distinct plus to identifying an imperfection. This observation is focused on the existing framework in which the operator acts as the first line of implementation of quality control. And other sewing stations in the first line quality control role have no operator to serve. Then the defect evaluation process was eventually completed and the best suggestion was found.

### **1.1 Objectives**

The main purpose of this study is to reduce the sewing defect that will degrade the rework rate and improve the system productivity. This study focuses on identifying and analyzing the significant causes of sewing defects and proposes several corrective actions to reduce those defects and ordered managerial decisions to emphasize on most significant actions.

## **2. Literature Review**

Quality is considered the most important factor in determining business (Irwin 1989) and a fundamental quality understanding is essential to run effectively in today's competitive markets (Kolarik W. 1995). The quality measures represent the most concrete action taken to date in expanding the basis of business performance measurement (Holloway J. 1995). The failure, however, may or may not lead to defects. These defects are non-conformities with specified requirements or with human requirements anticipations. Defects may or may not contribute to failure when they occur meeting the necessary requirements, as a faulty item may be able to both quality checks and assessments are carried out. This is proof of the fact that not every mistake leads to a fault and not every mistake a failure results in a defect (Nasreddin et al. 2006).

The Pareto analysis (statistical chart) is based on the observation that there is no universal distribution of operating results and economic resources and that certain inputs contribute more than others. To quickly differentiate between trivial and essential components, the Pareto analysis was used to (Talib et al., 2015; Bajaj et al., 2018). It is referred to as the '80/20 rule,' a terminology introduced by Vilfredo Pareto, an Italian economist of the nineteenth century, that has popularized a complex economic concept. The fundamental principle is that the majority of issues (about 80%) are always triggered by a limited number of sources (roughly 20 percent).

Root cause analysis is a problem-solving technique for determining the root causes of the problem's faults (Andersen & Fagerhaug, 2006). It is also known as the diagram of the fishbone and is a Complete Quality Control instrument that shows a process by showing the root causes and their origins. A variety of cause-effect diagrams have been used in this analysis to analyze and demonstrate identified defects by showing the major causes and sub-causes that contribute to an effect.

The PDCA cycle is employed to coordinate continuous improvement efforts. It both emphasizes and demonstrates that improvements programs must start with careful planning, must result in effective action, and must move on again to careful planning in a continuous cycle. The PDCA cycle contains a checklist of the four stages that one must go through to get from "problem-faced" to "problem solved". The four stages are: Plan: Defining objectives, identifying possible causes, come up with ideas to solve the problem. Do: Perform trial, Find solutions. Check: Verify result, Monitoring, Decision Act: Corrections, Implement in large scale, Review.

TOPSIS is a Multi-Attribute Decision-Making approach for selecting the best alternative. This method is chosen because it can select the best alternative from several alternatives based on the criteria specified or called Multi-Attribute Decision Making (saraf et al. 2013, Bulgurcu B et al. 2012, Ho W Xu X and Dey P K, 2010). The criteria are dynamic, its weight value can be changed as desired by the user. Then do the ranking process that will

determine the best employees that have been recommended. The parameters are dynamic and the weight value can be modified by the consumer as desired. Then do the rating process that will decide the best-recommended workers. The decision made is not definitive since it stays with the decision-maker as the final decision. (Risawandi R and Rahim R, 2016 Siregar 2017).

### 3. Methods

This study identifies and analyzes the defects that occur in the sewing section of an apparel firm and ranked different managerial decisions based on their impact. Here, an apparel firm named Fakir Apparels Limited was selected for this research work. Relevant information and sewing defects have been gathered by observing the sewing section. Later, Pareto Analysis has been performed to identify significant defects of concerning areas and a cause-effect diagram to investigate those causes that are responsible for these defects. Moreover, a Plan-Do-Check-Act (PDCA) cycle has been established to coordinate a continual improvement from occurring those defects. Later, a multi-criteria decision making (MCDM) technique has been used to prioritize the managerial

#### 3.1 Application of TOPSIS Method for selecting best decisions

Yoon and Hwang first developed a multiple criteria decision-making approach called TOPSIS. In this approach, several alternatives and criteria are considered for the decision making. The alternatives chosen must have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution from a geometrical point by using the Euclidean distance to determine the relative proximity of an alternative to the optimal solution. As the sum of all the best value that can be achieved for each attribute, the positive ideal solution is described, while all the worst value achieved for each attribute consists of the negative-ideal solution. TOPSIS takes account of both the distance from the positive ideal solution and the distance from the negative ideal solution by considering the relative proximity to the positive ideal solution.

The steps in calculating the TOPSIS method are demonstrated below-

Step 1: Establish a normalized decision matrix based on an initial decision matrix.

$$\bar{X}_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^n X_{ij}^2}}$$

Step 2: Calculate a Normalized weighted matrix

$$V_{ij} = \bar{X}_{ij} \times W_j$$

With the weight  $w_j = (w_1, w_2, w_3, \dots, w_n)$ , where  $w_j$  is the weight of the criteria for all  $j$  and  $\sum_{j=1}^n w_j = 1$ , The normalization of weight matrix  $V$ ,

$$V_{ij} = W_j \times r_{ij}$$

Step 3: Determining the ideal solution matrix of positive and negative ideal solution by using this formula:

$$V^+ = \{(\max v_{ij} | j \in J), (\min v_{ij} | j \in J'), i = 1, 2, 3, \dots, m\}$$

$$= \{V_1^+, V_2^+, V_3^+, \dots, V_n^+\}$$

$$V^- = \{(\min v_{ij} | j \in J), (\max v_{ij} | j \in J'), i = 1, 2, 3, \dots, m\}$$

$$= \{V_1^-, V_2^-, V_3^-, \dots, V_n^-\}$$

Step 4: Calculate the Euclidian distance from ideal best and ideal worse

$$S_i^+ = \left[ \sum_{j=1}^m (V_{ij} - V_j^+)^2 \right]^{\frac{1}{2}}$$

$$S_i^- = \left[ \sum_{j=1}^m (V_{ij} - V_j^-)^2 \right]^{\frac{1}{2}}$$

Step 5: Calculate Performance Best

$$P_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

Step 6: Denote rank based on the performance value.

## 4. Data Collection & Results

### 4.1 Identification of Sewing Defects applying Pareto Chart

During this research work in the sewing section, several types of sewing defects in two production line for two consecutive days has been observed. Table 1 and 2 shows the frequency of these defects in two production lines.

Table 1: Sewing Defects of Line 56

Defects Name	Defects Numbers
Missing	4
Wrong Placement	4
Broken/open stitch	31
Pleat	15
Skip	20
Wavy	46
Raw Edge	36
Uncut loose thread	50
Oil spot	14
Other defect	30
Shading rejection	4

Table 2: Sewing Defects of Line 57

Defects Name	Defects Numbers
Missing	10
Wrong Placement	0
Broken/open stitch	36
Pleat	21
Skip	6
Wavy	48
Raw Edge	49
Uncut loose thread	61
Oil spot	1
Other defect	16
Shading rejection	4

From the above data, Pareto analysis has been performed to identify most significant defects. Figure 1 and 2 shows the pareto chart of line 56 and 57 sewing defects.

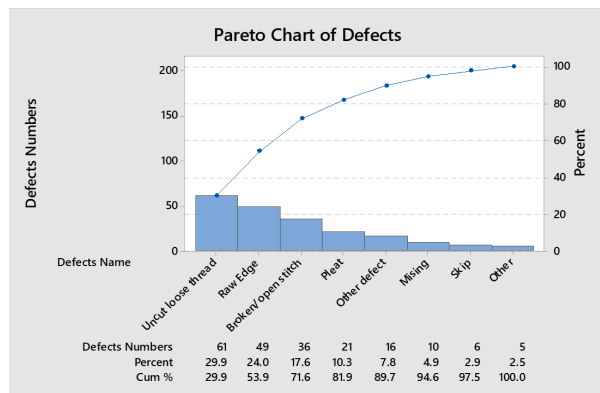


Figure 1: Pareto chart for defects in line 56

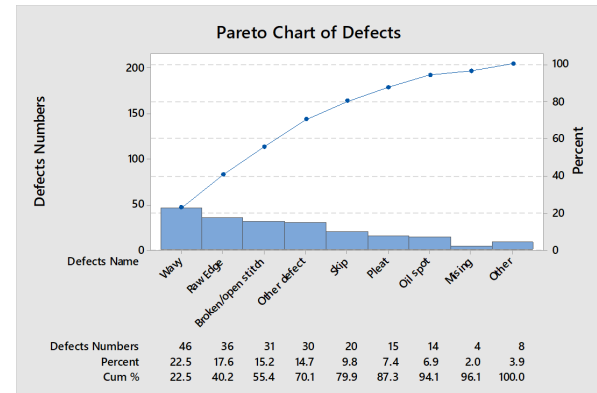


Figure 2: Pareto chart for defects in line 57

By observing the pareto chart, it can be concluded that, Raw edge is the most frequent defect of these two production lines comprising a total of 41.6%. The second most significant defect among this two line is Broken/Open stitch with 32.8% of the total. Figure 3 shows the significant defects and their percentage of occurring.

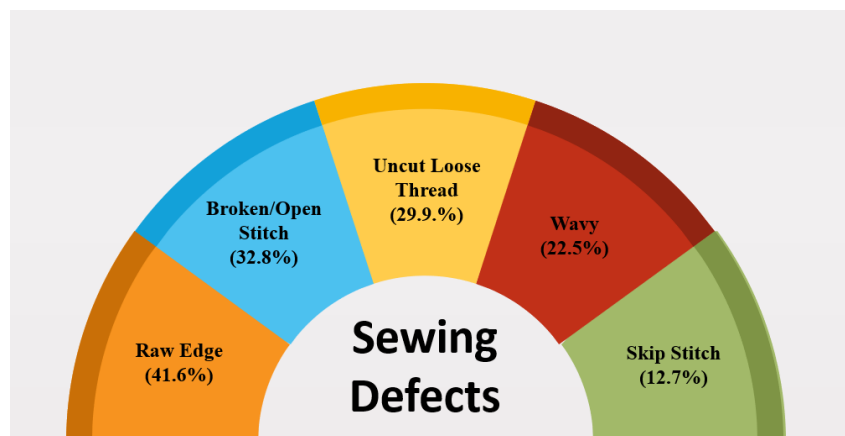


Figure 3:Major Defects obtained from Pareto Analysis

## 4.2 Investigating Root causes of the sewing defects

For identifying the root causes, the cause effect diagram of the major concerning defects has been investigated and illustrated in Figure 4, 5 and 6 and table 3.

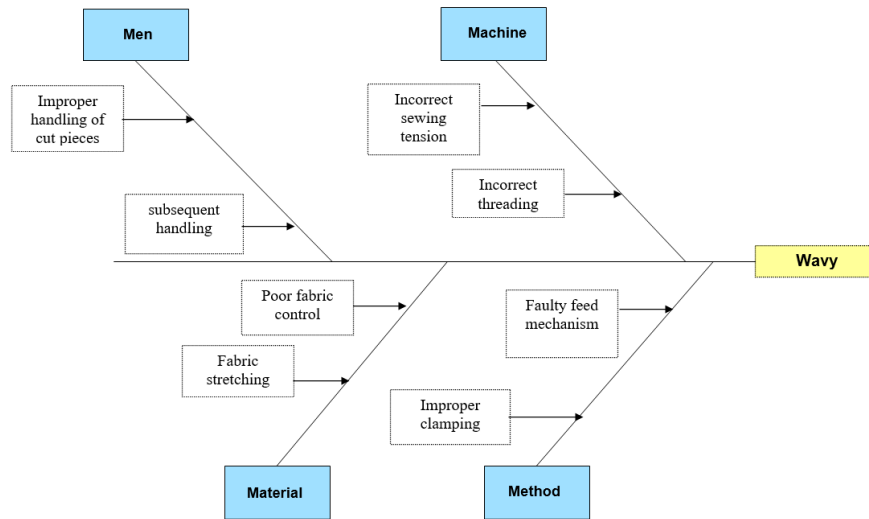


Figure 4: Cause effect diagram for Wavy

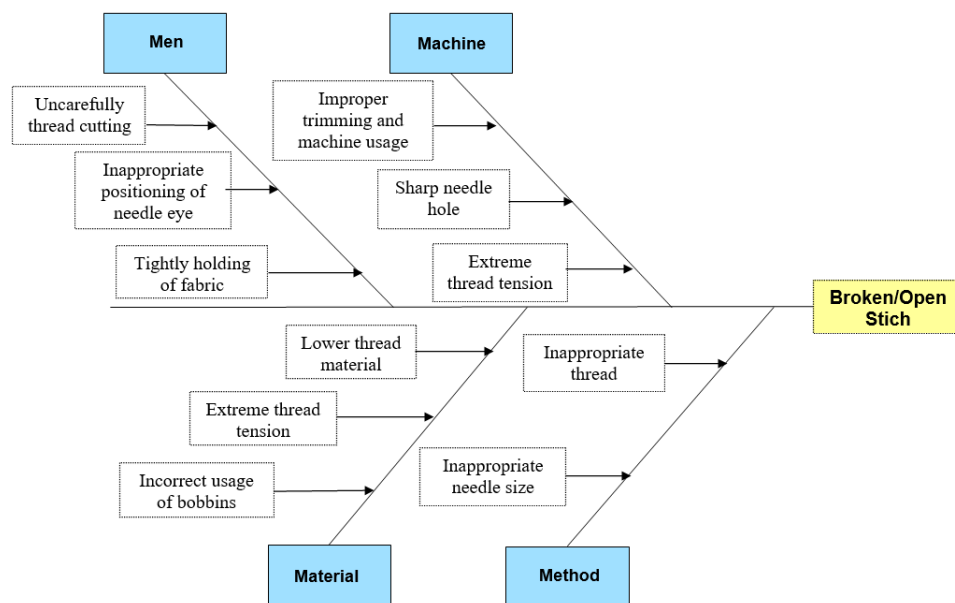


Figure 5: Cause effect diagram for Broken/Open Stich

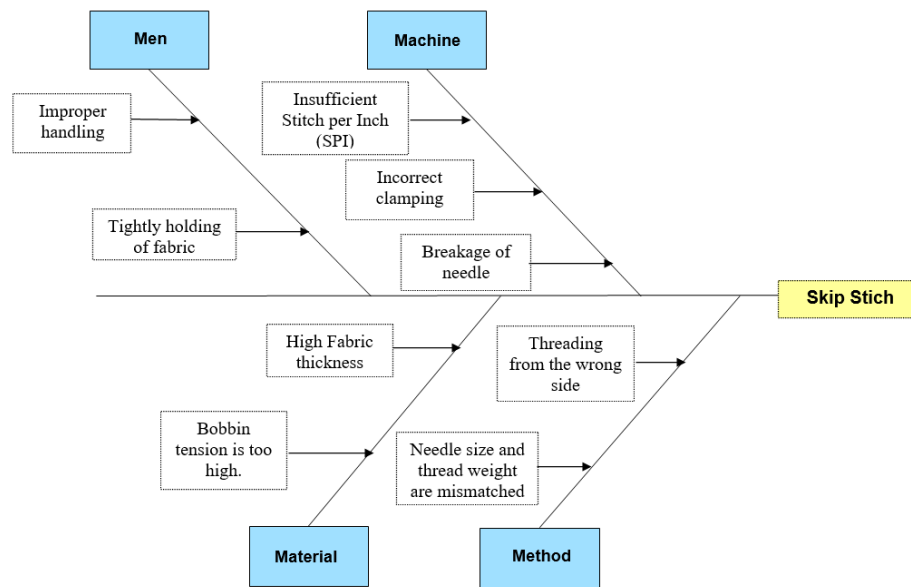


Figure 6: Cause effect diagram for Skip Stich

Table 3: Root causes of the defects and proposed corrective actions

Problems/Defects	Root cause analysis	Corrective Action
Raw Edge (41.6 %)	Operator Improper Handling, Failure of Machine knife, Faulty machine	Skilled worker adequate training and improved supervision Check machine and knife before sewing
Broken/Open Stitch (32.8 %)	Improper trimming and machine usage, Uncarefully thread cutting, Lower thread material, Sharp needle hole, Inappropriate positioning of needle eye, tightly holding of fabric, Inappropriate thread and needle size, Extreme thread tension, Incorrect usage of bobbins	Proper machine usage and trimming. Use of higher quality thread. Careful while cutting thread, Provide less tension on it, Checking the sharpness of needle point and balance between needlepoint and thread size Using larger threads during operations.
Uncut loose thread (29.9 %)	Improper trimming and finishing of fabric Sloppy workmanship	Provide thread cutter and adequate training to the Operators, Improve quality Inspection system
Wavy (22.5%)	Improper handling of cut pieces faulty feed mechanism. Improper clamping Fabric stretching, subsequent handling, Incorrect sewing tension, Incorrect threading,	Skilled workers and Specialization training. Adjust thread tension, Rethread machines Increase Pressure foot

	Poor fabric control,	
Skip Stitch (12.7 %)	Threading from the wrong side Machine or bobbin tension is too high. Improper handling High Fabric thickness Breakage of needle Failure of hook or looper and needle to enter loop at correct time. Needle size and thread weight are mismatched. Incorrect clamping Insufficient Stitch per Inch (SPI) Tightly holding the fabric	Check and rethread if necessary. Reset the needle, Long groove faces the direction of threading. Tighten presser foot screw. Replace with a new needle. Use thread with left.

#### 4.3 PDCA Cycle to Initiate Corrective Actions against Defects

A PDCA Cycle has been established in table 4 to propose reduce sewing defects considering continual improvement process.

Table 4: PDCA cycle considering corrective actions of sewing defects

Name of PDCA cycle	Expectation of actions	Tools
<b>Plan</b>	After root cause analysis 1. Consider a specific problem and the root causes of that problem. 2. Take necessary initiatives to implement the proposed corrective actions against these problems.	1. Observing the process 2. Process mapping 3. Evaluation Matrix 4. Brainstorming 5. Flowcharting
<b>Do</b>	1. Establish experimental success criteria 2. Divide the overall system into individual processes 3. Implement the actions on a trial or pilot basis	1. Establish Standard Operating Procedure 2. Experiment design 3. On-the-job training 4. Employee management and communication
<b>Check</b>	Evaluate the results: 1. Gather/analyze data on the solution Achieve the desired goal: 1. If YES go to act 2. Or else go to plan, revise defects and root causes	1. Direct observation of the process 2. Graphical analysis 3. Control charts 4. Key performance indicators
<b>Act</b>	1. Identify systemic changes, resource allocation and, training needs for full implementation 2. Plan ongoing monitoring of the solution 3. Continuous improvement 4. Look for other improvement opportunities	1. Process mapping (new process) 2. Process Standardization 3. Error proofing 4. Formal training for standard processes



#### 4.4 Prioritize Managerial decisions employing TOPSIS

For prioritizing the managerial decisions, a multi criteria decision making (MCDM) technique named Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has been employed and shown in table 5-9.

Table 5: Managerial Decisions

Serial No.	Alternatives
1	Skilled Manpower
2	Specialized Training Program
3	Improve Quality Inspection system
4	High Quality Material
5	State of the art machines

Table 6: Managerial decision Criteria

Serial No.	Criteria
1	Raw Edge
2	Broken/Open Stitch
3	Uncut Loose Thread
4	Wavy
5	Skip Stitch

Table 7: Direct-weight Matrix

weightage	0.35	0.25	0.2	0.15	0.1
	1	2	3	4	5
1	10	6	8	10	5
2	10	8	9	9	7
3	9	8	10	7	8
4	4	5	10	10	10
5	9	10	5	9	10

Table 8: Normalized Matrix

	1	2	3	4	5
1	0.514	0.353	0.416	0.493	0.272
2	0.514	0.471	0.468	0.444	0.381
3	0.463	0.471	0.520	0.345	0.435
4	0.206	0.294	0.520	0.493	0.544
5	0.463	0.588	0.260	0.444	0.544

Table 9: Weightage Normalized Matrix

	1	2	3	4	5	Si+	Si-	Pi	Rank
1	0.180	0.088	0.104	0.074	0.027	0.118	0.070	0.372	2
2	0.180	0.118	0.117	0.067	0.038	0.129	0.037	0.222	5
3	0.162	0.118	0.130	0.052	0.044	0.121	0.042	0.260	4
4	0.072	0.074	0.130	0.074	0.054	0.074	0.131	0.639	1
5	0.162	0.147	0.065	0.067	0.054	0.120	0.068	0.361	3

This calculation implies a ranking of managerial decisions where priority should emphasize on high quality materials, skilled manpower, effective machines, improved quality inspection system and specialized training program respectively.

## 5. Conclusion and Future work

Quality defects are considered a major concern not only in apparel manufacturing industries but also almost in every sector of industries where consumers endeavor it. For the apparel industry, quality is assessed in terms of quality and standard of fibers, fabric quality, designs, and the finished garments. However, these defects in the product usually lead to rework, scrap, reject, additional processing time, and customer dissatisfaction which is not beneficial for a growing industry. This study has investigated and analyzed the sewing defects in an apparel firm employing Total quality management (TQM) tools such as Pareto chart, cause-effect diagram, PDCA cycle, and a multi-criteria decision making (MCDM) technique referred Order Preference by Similarity to Ideal Solution (TOPSIS). The Pareto chart reveals that the major cumulative sewing defects such as raw edge (41.6%), broken/open stitch (32.8%), uncut loose thread (29.9%), wavy (22.5%) and skip stitch (22.5%). Employing a cause-effect diagram, the root causes of each sewing defect has been identified, and several corrective actions have been recommended to defeat those defects. Moreover, a Plan-Do-Check-Act (PDCA) cycle has been established to propose a continual improvement of these defects. For emphasizing more importance on proposed managerial decisions, a TOPSIS approach has been employed to systematize those decisions in order. This managerial preference will help management to implement effective decisions for minimizing sewing defects. This study has been conducted on a particular section of the apparel manufacturing firm, while it can be extended considering other areas of this industry. A quality assurance system can also be incorporated for trailing the improvement after implementing the proposed remedial actions. In terms of efficiency and effectiveness, the consequence of this study can help the sewing section to focus more on concerning areas that bring significant advances in the sewing section of the apparel business.

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