

Reducing Sewing Defects in RMG Manufacturing for Continuous Improvement: A PDCA Framework Approach

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Abstract

The objective of this research is to implement Plan-Do-Check-Act (PDCA) cycle to reduce common sewing defects found in 14 days timeframe. The common sewing defects were found through the pareto chart, which include broken stitches, raw edges, and uncut threads, which harms the production quality and costs. Fishbone diagram is used to search for the root causes. The 5WH (who, what, when, where, why, and how) technique helps develop practical solutions, thus completing the planning stage. After the application of PDCA, an audit was done, that shows the average defective production drop went from 12.61% to 8.09% as well as the average number of defects per hundred units (DHU%) decreased from 14.66% to 9.00%. These results prove that PDCA is useful for reducing defects. In conclusion, this study is done to highlight the wider range of the use case of PDCA cycle in garments industries.

Keywords

Sewing Defects, Root causes, Pareto Analysis, 5WH Question, Quality Circle PDCA.

1. Introduction

The apparel manufacturing industry has become an important part of global trade and economic growth because of high competition and technological advancement which is necessary to have good product quality and smooth production. But still many sewing defects like broken stitch, raw edge, and puckering happen, and these problems increase production cost, create more waste, cause rework, and delay the delivery time. Because of these issues, customer satisfaction also goes down. Most of the time these defects come from things like low operator skill, wrong machine setting, bad-quality fabric or thread, and production process not being stable.

Bangladesh is one of the biggest exporters of ready-made garments (RMG) in the world, and this sector makes almost 84% of the country's total export earnings and gives jobs to millions of people. However, the sector struggles with maintaining consistent garment quality due to facing these common sewing defects. Furthermore, many factories following the traditional, reactive quality control methods fail to address root causes of defects. On the contrary, it is

suggested in studies that modern quality management systems, such as Total Quality Management (TQM), Root Cause Analysis (RCA), and Lean Manufacturing can significantly tend to improve efficiency and reduce defects.

To minimize the addressed sewing defects, this research applies the Plan-Do-Check-Act (PDCA) framework. PDCA takes a systematic and structured approach to continuously identify issues, to implement corrective actions, and to check progress.

The study shows that visible improvements as defect percentage decreased from 12.61% to 8.09%, and DHU (Defects per Hundred Units) dropped from 14.66% to 9.00%. These results show that PDCA can effectively improve both product quality and operational performance. This research also tries to show that our RMG factories in Bangladesh should follow a proper and organized quality improvement system. By doing this, they can match international standards better, cut down waste in production, and improve their position in the global market in a more stable and sustainable way.

1.1 Objectives

This research primarily aims to establish and implement a framework within a garment production environment to reduce the occurrence of sewing defects. More specifically, this research aims:

1. To implement the Plan-Do-Check-Act (PDCA) framework as a methodical approach to reduce sewing defects in garment manufacturing.
2. To reduce the Defective% and DHU% (Defects per Hundred Units) in the garment production process by applying targeted interventions such as operator training, equipment maintenance, and process standardizing.

2. Literature Review

The ready-made garment (RMG) industry is the backbone of Bangladesh's economy – responsible for a large share of its GDP and the vast majority of its foreign exchange earnings. Nonetheless, in the context of global competition, defects in product sewing operations, which are another part of production operations, need to be minimized. Scrutiny towards the PDCA Model for continuous improvement in garment manufacturing. The garment industry is very important for Bangladesh's economy. It makes almost 81% of the country's export income and gives jobs to more than 4 million people (M Masum Alam et al., 2018; Mnh, 2021). While the industry is still growing rapidly globally, it continues to contend with long-standing issues associated with production defects, quality variation, and labor inefficiencies, all of which limit growth and profitability. Stitching mistakes, seam puckering, broken stitches, and fabric defects not only cause high rework and extra material waste, but they can also lead to order cancellations and financial loss for the factory (Chowdhury et al., 2014).

Quality improvement is essential for Bangladesh's garment industry to sustain itself in the international market. Minimization of sewing defects affecting quality and productivity can be achieved using systematic tools like the PDCA framework (Islam & Islam, 2017; M Masum Alam et al., 2018).

Root Cause Analysis (RCA) is very helpful to find the real reasons behind sewing defects and fix them. Usually, tools like the fishbone diagram and 5 Whys are used to look into problems caused by workers' mistakes, machine issues, or material defects (Kapuria et al., 2017). RCA not only helps identify these defects but also provides suggestions to prevent them from happening again (Jony Moin et al., 2023).

Cause-and-effect diagrams are useful for tracing issues such as poor machine maintenance or improper thread tension. For instance, (Lingkon et al., 2024) showed that broken stitches often happen when the wrong needle is used. In the same way, (Islam & Islam, 2017) reported that the most common defects are uncut threads, broken stitches, and uneven seams. In their studies, 23.16% defects were uncut threads. This leads to defects that are mainly caused by operator shortcomings, incorrect machine settings, and the use of low-quality materials (M Masum Alam et al., 2018). The PDCA cycle is widely used in garment industries to improve production quality and reduce defects. For example, (Atsegeba et al., 2025) applied PDCA together with the 5S method in a sewing line and achieved about a 25% drop in defects. PDCA gives us a structured way to identify and correct different inefficiencies, which helps lower defect rates and improve overall efficiency (M. M. Islam et al., 2013).

Beyond garments, PDCA also works well in many other sectors. It has been successfully used in the automotive and healthcare fields. To make processes more efficient and reduce waste PDCA was integrated into Toyota's Lean Manufacturing system (Singh et al., 2024). Several modifications and improvements in manufacturing industries stem

from adaptive PDCA cycles in their process control, one instance being the iterative cycles of PDCA in aluminum alloy casting that successfully reduced the defect rates (Al-Bakoosh et al., 2020).

Studies show that using the PDCA cycle in sewing lines can reduce defects by around 15% and increase productivity by about 10% (Lingkon et al., 2024). These findings suggest that sewing defects can be lowered when different improvement techniques are applied together instead of using only one method. To achieve better quality, factories should give workers proper training, ensure machines are maintained on time, identify the real reasons behind each defect, and strictly follow quality management procedures in the production line. Specifically, these types of interventions that fit a production line can hugely improve production quality and efficiency. While there are some studies investigating defect reduction of RMG (Ready-Made Garment) industries, to the best of our knowledge none has adopted such a systematic step by step process with strict adherence to PDCA like in this research. What makes this study unique is that a 5WH (What, How, Where, Who, Which) question approach was implemented in the Quality Circle principles to directly engage the production team with identifying and analyzing defects. This method focuses on finding the real reasons behind the defects, not only the problems we see outside. It does this by looking at things like operator training, machine maintenance, and how well the processes are standardized.

3. Methods

The content of this chapter is a detailed account of the methodologies adopted to take care of sewing defects in garment production. It systematically identifies problems, implements solutions, and establishes measurable outcomes. Detailed methodology helps develop a balance between theory and practical approach of garment manufacturing. Integrating Delphi method with root-cause analysis ensures that the reasons for defects are known and a robust improvement framework tailored to the specific defect provides a structured way forward to rectify sewing defects.

3.1 Research Steps

The research process involved several critical steps, each building upon the previous to ensure a robust and systematic approach. Next, Figure 1 shows all the steps of this research methodology.

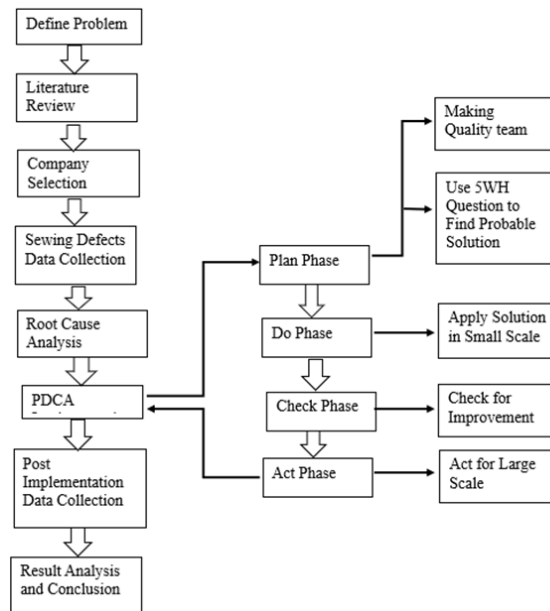


Figure 1. Flowchart of research methodology

3.1.1 Define the Problem

The study initiated the process by highlighting that sewing defects are a persistent and significant problem in garment manufacturing. In the studies, it was concluded that sewing defects would severely affect the efficiency of production,

quality of the product, and costs as a result of rework, waste of yarn, and time. Based on initial observations and discussions, we identified the need for a structured process for this task. Then, the scope was narrowed onto a production line, with an abnormal amount of defects.

3.1.2 Pre-Intervention Data Collection

Daily production and defect data were collected over a 14-day period before any interventions were put in place. Among what they tracked were key metrics such as:

- Total production volume.
- The types and frequency of sewing defects.
- Daily defect percentages. Defects were classified in terms of their types, such as Broken Stitch, Raw Edge, Puckering and Skip Stitch, according to standard categories used in the garment sector. Using this data, Pareto charts were used to identify which defects were most frequent and critical in that they accounted for the majority of quality problems.

3.2 Root Cause Analysis

The next step was to use fishbone diagrams to investigate the root causes of the major defects identified through Pareto analysis. The analysis identified four broad categories of causes:

Man: The operator skills, training and awareness related issues.

Machine: Issues like incorrect settings, insufficient maintenance, or defective parts.

Material: The quality of fabric or thread can vary.

Method: Inconsistency in SOPs or wrong methods.

3.3 The PDCA Framework Implementation

The PDCA framework was practiced as the primary intervention mechanism to systematically tackle the sewing defects identified.

3.3.1 Plan Phase

In the Plan phase: A Quality Circle team consisting of line managers, QC staff, and seasoned operators was established. This Group was accountable for designing and executing solutions. The team did a **5WH** questionnaire and highlight the doable solutions shown in Figure 2.

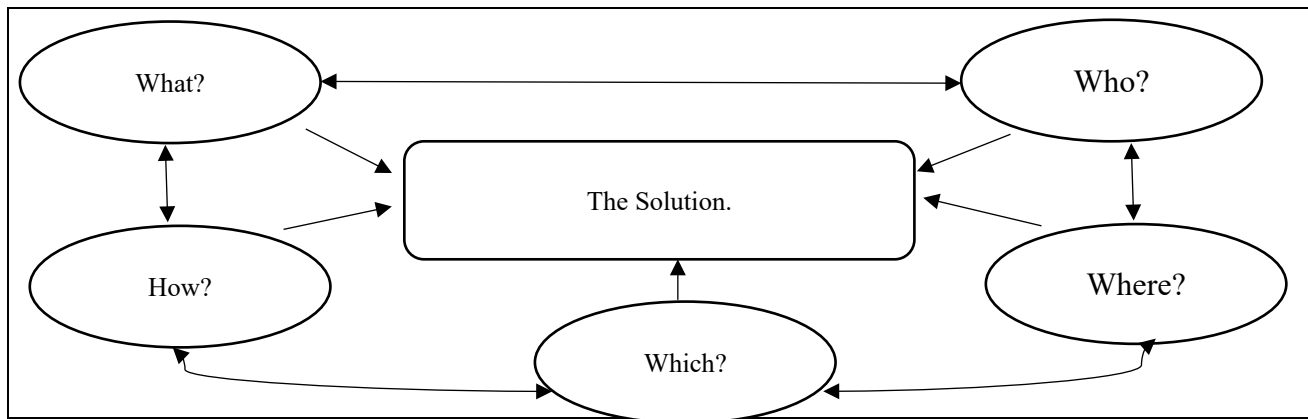


Figure 2. 5WH question diagram

Based on the root cause analysis and insights from brainstorming sessions, solutions were proposed.

3.3.2 Do Phase

The Do phase was focused on testing the proposed solutions on a small scale to determine their effectiveness:

Man-Related Interventions: Standard operating procedures were trained on two inexperienced operators. Daily briefings encouraged operators to follow defect-prevention practices.

Machines Related Interventions: Old needles and bobbins were swapped out. They recalibrated their machines to adjust the thread tension, feed dogs, and pressure foot settings. Oil seals and other faulty components were replaced.

Method-Related Interventions: Available samples ensured threads quality and types matched the fabrics.

Material-Related Interventions: Operators were re-trained on SOPs, while key processes like stitch length and seam allowance were standardized.

3.3.3 Check Phase

In the Check phase:

- Data was gathered post intervention on 14 days to assess the impact of all solutions implemented.
- These data sets were reviewed to determine defect rates in production and efficiencies in both production processes during workup compared to data prior to intervention.
- This analysis confirmed that the solutions were effective but also highlighted aspects that still needed adjustment.

3.3.4 Act Phase

The Act phase was about standardizing successful interventions and ensuring sustainability:

The quality team implemented a full-scale intervention across the production line. The preventative measures became institutionalized as higher standards of cleanliness, organization and attention to detail for things like regular machine maintenance and operator training, as well as daily checks of thread tension and fabric quality. Operators were advised to immediately notify supervisors of any problems so that they could be addressed in a timely manner.

3.4 Tools and Techniques

The following tools were utilized throughout the study:

- **Pareto Charts:** To identify and prioritize the most frequent defects.
- **Fishbone Diagrams:** To analyze the root causes of critical defects.
- **Quality Circles:** To encourage employee participation in identifying, analyzing, and solving problems related to production defects, promoting continuous improvement.
- **5WH Questionnaire:** To propose actionable solutions during the Plan phase.
- **Defect Checklists:** To track daily production and defect occurrences.
- **Comparative Analysis:** To evaluate the effectiveness of interventions by comparing pre- and post-intervention data.

The whole approach applied in this study problem description, literature evaluation, industry selection, data collecting, root cause analysis, and PDCA framework application has been described in this chapter. Through methodically fixing sewing flaws, the study shows how well-organized interventions help to raise production efficiency and quality.

4. Data Collection

Data was gathered from a designated sewing line over the course of 14 working days in order to detect and examine sewing flaws in the manufacturing line. At optimal levels, the line's capacity was 1,500 units.

The defective percentage was determined by dividing the number of defective units by the total number of units produced. This ratio was expressed as a percentage:

$$\text{Defective\%} = \frac{\text{Defect unit}}{\text{Produced unit}} \times 100 \dots\dots\dots (i)$$

Another metric is Defects per Hundred Units (DHU). It is a critical quality metric in manufacturing that quantifies the number of defects found per 100 inspected units.

$$\text{DHU\%} = \frac{\text{Total number of defects}}{\text{Total Number of inspected unit}} \times 100 \dots\dots\dots (ii)$$

As at the end of the line all the product is inspected so,

Total produced unit = Total inspected unit.

The following Table 1 shows all the data before implementing PDCA in the sewing line.

Table 1. Data of 14 days before implementing PDCA

Day	Line Capacity (unit)	Produced Unit	Defect Unit	Defective %	Defect Quantity	DHU%
Day 1	1500	1285	217	16.89%	243	18.91%
Day 2	1500	1463	195	13.33%	220	15.04%
Day 3	1500	1126	203	18.03%	209	18.56%
Day 4	1500	1188	135	11.36%	172	14.48%
Day 5	1500	1297	194	14.96%	206	15.88%
Day 6	1500	1184	159	13.43%	165	13.94%
Day 7	1500	1056	110	10.42%	177	16.76%
Day 8	1500	1127	114	10.12%	179	15.88%
Day 9	1500	1032	104	10.08%	132	12.79%
Day 10	1500	1168	179	15.33%	194	16.61%
Day 11	1500	1412	190	13.46%	193	13.67%
Day 12	1500	1319	113	8.57%	128	9.70%
Day 13	1500	1058	106	10.02%	108	10.21%
Day 14	1500	1143	121	10.59%	146	12.77%

The collected data gave a clear baseline that helped identify the key performance indicators, understand which defects were happening repeatedly, and plan proper improvement actions by using the PDCA method.

4.1 Identification Defects

Over the first 14 days, daily data was gathered from the sewing line, recording certain kinds of defects and the count of defective items.

Here are the defects –

- Raw Edge
- Process Missing
- Uncut Thread
- Broken Stitch
- Pleat
- Oil Stain
- Hole Missing
- Slanted
- Down Stitch
- Puckering
- Skip stich

4.2 Defect Frequency

The next table (Table 2) shows the daily frequency of the selected line over 14 days It shows the frequencies of certain defects such as puckering, raw edges, and broken stitches, as well as the corresponding daily figures. Such a wide spectrum of information leads to easier detection of recurring issues, as it compares the spread, and numbers of each class of defects.

Table 2. Defects frequency data of 14 days before implementing PDCA

Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Total
Defect Unit	217	195	203	135	194	159	110	114	104	179	190	113	106	121	
Defect Quantity	243	220	209	172	206	165	177	179	132	194	193	128	108	146	2472
Raw Edge	48	24	32	9	16	19	28	58	15	13	53	34	21	8	378
Process Missing	6	10	25	19		12	10		15	18		4	17	29	165
Uncut Thread	18	38	54	12	35	18	36	8	14	26	38		14		311
Broken Stitch	28	25	33	39	13	53	34	39	42	60	29	27	30		452
Pleat		19	1			8	8	2	4	16		3		17	78
Oil Stain	47	15		12	43	15	8			10	6			28	184
Hole Missing	3	10	3			9	22		4		16		2	21	90
Slanted	4	6	21		13	10		6	9		3	10	12	4	98
Down Stitch		8		18			19	13	8			14		3	83
Puckering	22	14	40	37	56			25	14	9	26		8	36	287
Skip Stich	65	43		26	30	21		23		38	19	27			292
Others	2	8					12	5	7	4	3	9	4		54

4.3 Pareto Chart Analysis

Conducting a Pareto analysis to organize the top contributors to the overall defect rate, results are shown in Table 3

Table 3. Pareto analysis table

Defects	Occurrence	Percentage of Occurrence	Cumulative % Occurrence
Broken Stitch	452	18.28%	18.28%
Raw Edge	378	15.29%	33.58%
Uncut Thread	311	12.58%	46.16%
Skip stich	292	11.81%	57.97%
Puckering	287	11.61%	69.58%
Oil Stain	184	7.44%	77.02%
Process Missing	165	6.67%	83.70%
Slanted	98	3.96%	87.66%
Hole Missing	90	3.64%	91.30%
Down Stitch	83	3.36%	94.66%
Pleat	78	3.16%	97.82%
Others	54	2.18%	100.00%
Total	2472		

In statistical terms, the 80/20 rule, the majority of defects comes from a small number of defect types (Figure 3).

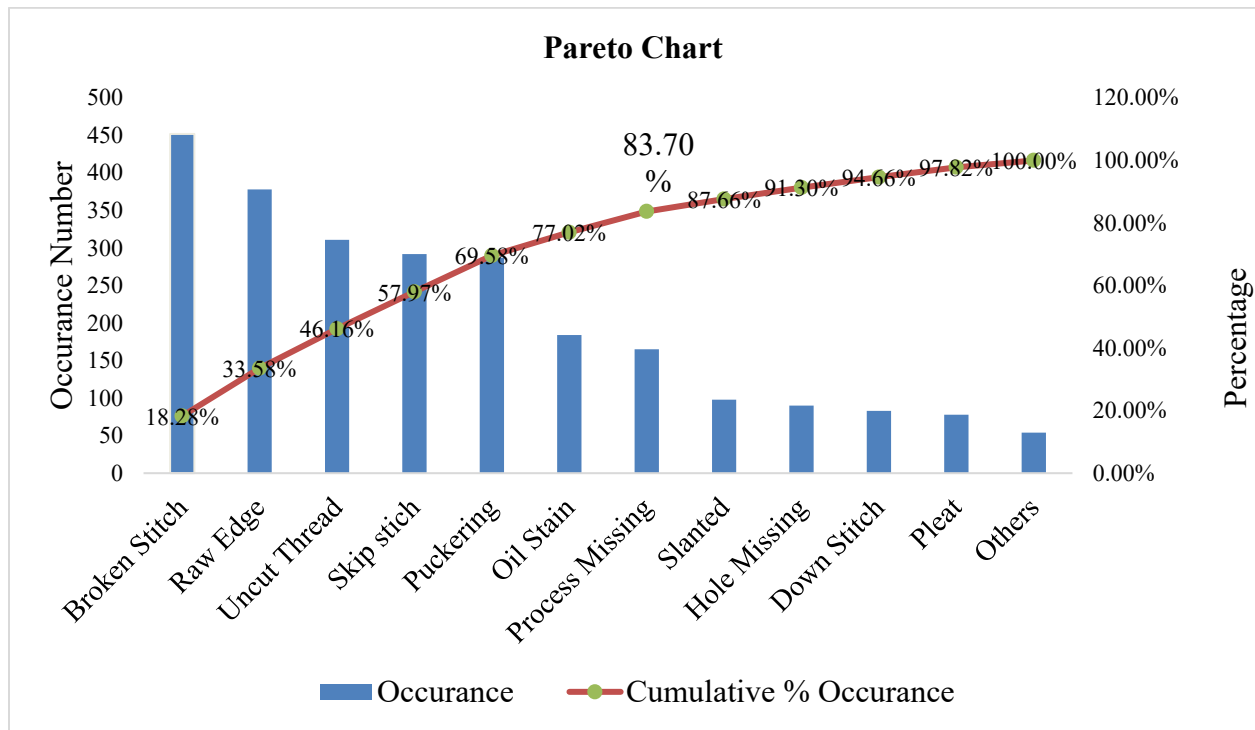


Figure 3. Pareto chart

4.3.1 Three Major Defects

Analysis shown in the Pareto chart revealed that before the improvements, the top three defect types - Broken Stitch, Raw Edge, and Uncut Thread - comprised 46.16% of total defects 9. From the Pareto chart, we can see that the first seven defects account for 83.70% of the total defects. This research focused on the first three defects as these are most common (Figure 4- Figure 6).

A. Broken Stitch:

Broken stitch was a frequently occurring defect identified during the data collection. It is caused by issues such as improper machine settings, damaged needles, or operator errors, affecting garment quality.

B. Raw Edge:

Raw edge was the second most occurring defect during the data collection period. It typically results from improper machine settings or missing edge finishing steps, impacting the garment's durability and appearance.

C. Uncut Threads:

Uncut threads were a common defect caused by operator oversight or dull trimming tools, affecting the garment's finishing quality.



Figure 4. Broken Stitch



Figure 5. Raw Edge



Figure 6. Uncut Thread

4.4 Root Cause Analysis Using Fishbone Diagram

In this paper Root Cause Analysis (RCA) was done by the Fishbone Diagram (Ishikawa Diagram). This tool is allowed for a systematic categorization of causes under four key categories: Man, Machine, Material, and Method (Figure 7- Figure 10).

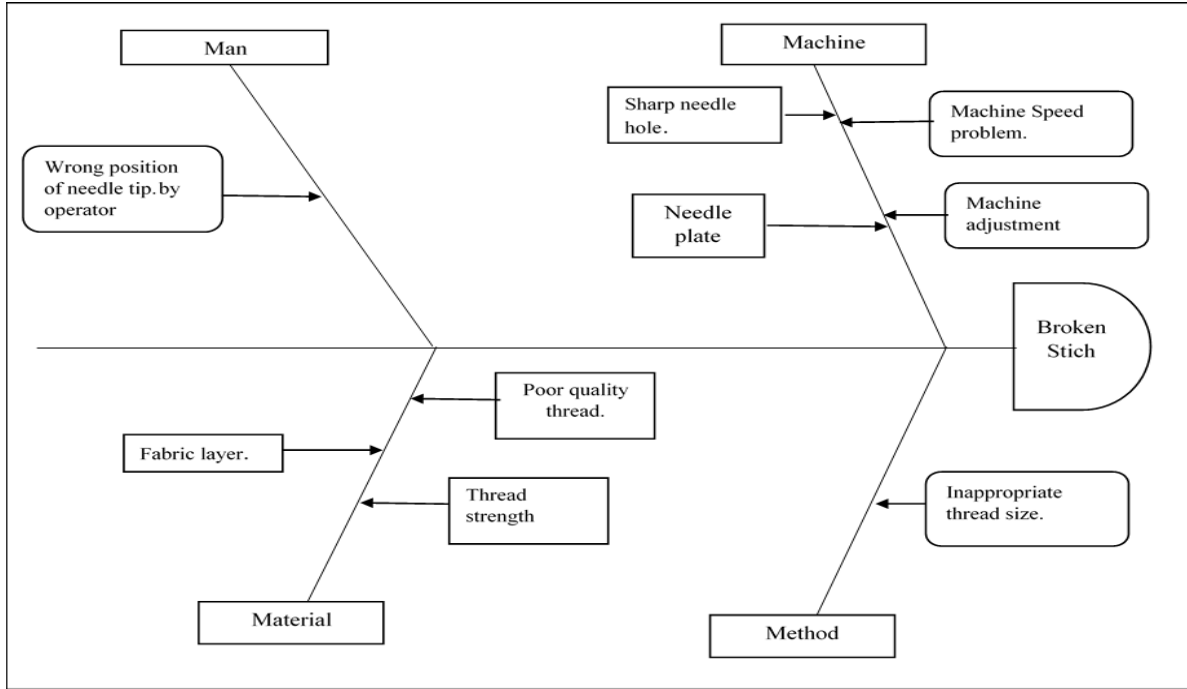


Figure 7. Fishbone diagram for Broken Stich

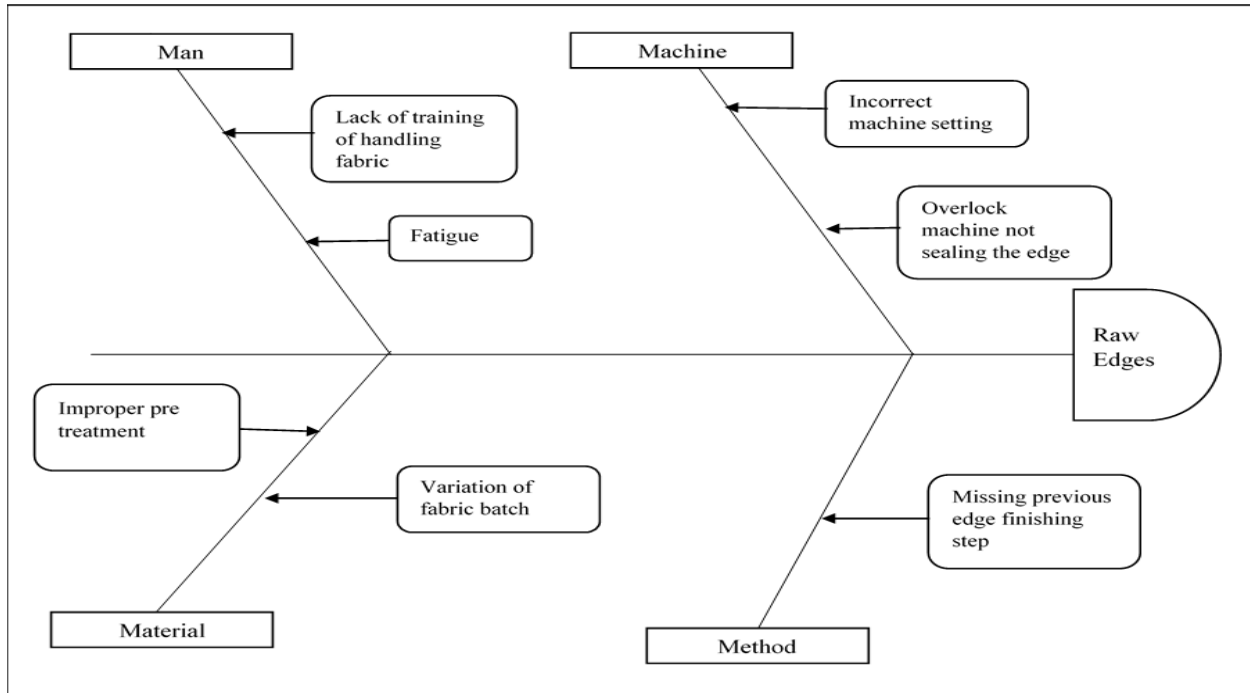


Figure 8. Fishbone diagram for Raw Edge

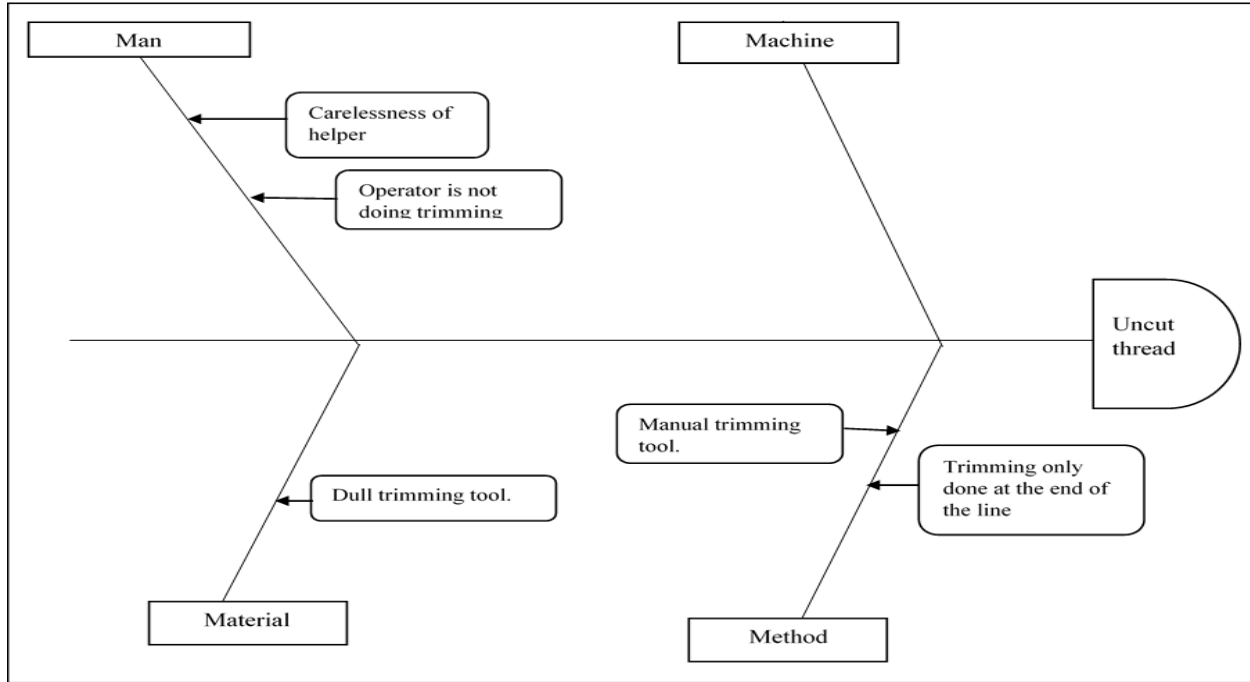


Figure 9. Fishbone diagram for Uncut Thread

4.4 Application of the PDCA Framework

The implementation of the PDCA framework follows a structured cycle consisting of four phases: Plan, Do, Check, and Act. The following diagram (Figure 10) visually represents the PDCA cycle, outlining the key actions taken at each stage.

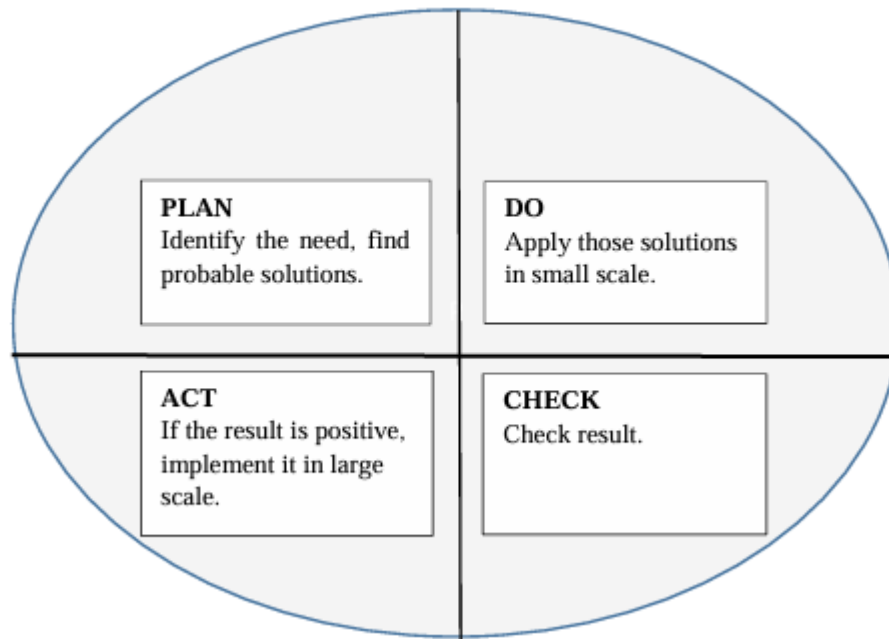


Figure 10. Diagram for PDCA

4.4.1 Plan Phase

A quality circle of five members was formed for this study. The team included one Line Supervisor, one QC member, one Maintenance guy, and two Expert Operators. These members were selected so that different areas like supervision, quality control, machine maintenance, and operation experience could be involved in the improvement activities. With the assistance of Quality Circle, we used 5WH questions (showed in Table 4) to find a probable solution for most occurring defects.

Table 4. 5WH question for finding solution

No.	5WH Question
1.	What can we do?
2.	How will we do it?
3.	Where does it need to be done? Or Where is the change needed?
4.	Who should do it?
5.	Which method or material is causing the problem?

Using these questions, we found probable solutions to these defects. Provided in Table 5.

Table 5. Defects probable solution.

Defect Name	Probable Solutions
Broken stitch	<ul style="list-style-type: none"> • Train operators on proper needle positioning and handling techniques. • Adjust the sewing machine speed. • Replace worn out or damaged needle plate. • Use thread according to fabric. • Provide guidelines for appropriate thread needle combinations.
Raw Edge	<ul style="list-style-type: none"> • Train operators in fabric handling • Regularly calibrate and maintain machines, especially overlock machines, for proper edge sealing • Ensure proper pretreatment to prevent fraying.
Uncut Thread	<ul style="list-style-type: none"> • Motivate operators to do their own trimming. • Motivate helpers to be more careful. • Replace dull trimming tools. Schedule change of dull trimming tool. • Install 2 more stations dedicated to trimming. • If possible, use an automated trimming machine.

4.7.2 Do Phase

During the Do phase, the quality team actively participated in putting the intended solutions into practice. Standard Operating Procedures (SOPs) for their different processes were taught to two inexperienced operators to guarantee consistency and quality in their work. The operators were also trained to handle basic technical issues and machine-related problems by the maintenance staff, which allowed them to handle minor issues on their own.

4.7.3 Check Phase

We assessed in the Check phase the effects of the interventions carried out during the Do phase. Operator-related faults were noticeably reduced by the new Standard Operating Procedure training programs for both the two operators. Minimizing the machine problems was achieved by both the maintenance team's repairs of mechanical problems and basic technical handling instruction to operators.

This stage guaranteed that the solutions implemented during the Do phase had indeed addressed the discovered issues. Should the confirmed outcome be positive, this enhancement will be applied all across the production line for additional use during the Act phase.

4.7.4 Act Phase

The verified Do phase enhancements were standardized and extended over the whole manufacturing line in the Act phase. Here are the steps taken and changes done showing in Table 6.

Table 6. Action phase solution

Category	Steps Taken
Man related:	<ul style="list-style-type: none"> The quality team circled the entire production line for the next two days, spending a minimum of a few minutes at each station to provide assistance to inexperienced operators or any operators who were having difficulty adhering to the SOPs. Operators were motivated and aware of the defects.
Machine related:	<ul style="list-style-type: none"> 1 machine had total maintenance. 12 machines had replacement of dull or worn-out sewing needles. Check all the machines for thread tensions. 4 machines had rethreaded. 5 machines had change of damaged bobbins. 17 machines had recalibrated feed dog. 9 machines had readjusted pressure foot pressure. 3 machines had damaged oil seal changed. Operators and helpers were given new or sharp trimming tools and scissors.
Material related:	<ul style="list-style-type: none"> Make sure everybody has fabric wise good quality thread. For linen shirts it is polyester thread.
Method related:	<ul style="list-style-type: none"> SOP is reintroduced to the people who are needed. For SNLS machine, RPM should be at 2500-3000 RPM.

	<ul style="list-style-type: none"> • For critical process, RPM should be around 1800 RPM. • Needle size should be 80/12. • Thread tension dial always should be in 3-4 on dial, • Stitch length should be no more than 3mm, • Critical process stitch should be no more than 2.5 mm. • Seam allowance is given but not more 5 mm
Others change:	<ul style="list-style-type: none"> • Operators were instructed early morning before production starts; they should check thread tension and check if the thread is appropriate for the fabric. • If any operator finds a fabric related problem, the operator should instantly notify line supervisor. • A light maintenance had scheduled every 4 days. Needle and trimming tools should be changed every 15 days. • In their current 5S operators were instructed not only to clean their workstation but also to clean the inside of the machine. Use sponge bar to clean machine for oil leak and oil seal.
Steps for future:	<ul style="list-style-type: none"> • Every morning there should be an announcement of fabric and thread type. • Whenever the product is changed, there should be one training program.

These steps guarantee the longevity of the gains, therefore promoting a culture of ongoing quality advancement and operational efficiency all around the sewing line. Between Day 10 and Day 14, these activities were carried out and watched to make sure Do phase developments were successfully included into the manufacturing process.

5. Results and Discussion

5.1 Numerical Results

The PDCA framework was demonstrated to be a successful instrument for improving the quality of production and reducing sewing defects in the production of linen shirts. The average defective percentage decreased by 35.86% which is the result of total defective piece from 2140 to 1408 and the total number of defects decreased from 2,472 to 1,566 as DHU%, decreasing from 14.66% to 9.00%, showcasing the effectiveness of the approach in enhancing product quality and minimizing defects (Table 7).

Table 7. Line efficiency table

Metrics	Before Implementing PDCA	After Implementing PDCA
Total production	16858	17163
Total defective units	2140	1408
Average defective %	12.61%	8.09%
Total Defects	2472	1566
Average DHU%	14.66%	9.0%
Line efficiency	59.31%	59.44%

5.2 Graphical Results:

In this section, a thorough comparison of daily production and defects data prior to and following the utilization of the PDCA framework is provided (in Table 8).

Table 8. Comparison table

Before implementing PDCA					After implementing PDCA				
Day	Produced Unit	Defect Unit	Defective %	DHU%	Day	Produced Unit	Defect Unit	Defective %	DHU%
Day 1	1285	217	16.89%	18.91%	Day 15	1458	192	13.17%	14.1%
Day 2	1463	195	13.33%	15.04%	Day 16	1252	77	6.15%	6.7%
Day 3	1126	203	18.03%	18.56%	Day 17	1068	73	6.84%	8.0%
Day 4	1188	135	11.36%	14.48%	Day 18	1353	85	6.28%	6.9%
Day 5	1297	194	14.96%	15.88%	Day 19	1236	82	6.63%	7.8%
Day 6	1184	159	13.43%	13.94%	Day 20	1424	128	8.99%	10.7%
Day 7	1056	110	10.42%	16.76%	Day 21	925	60	6.49%	7.9%
Day 8	1127	114	10.12%	15.88%	Day 22	1145	123	10.74%	11.3%
Day 9	1032	104	10.08%	12.79%	Day 23	1182	88	7.45%	9.1%

Day 10	1168	179	15.33%	16.61%	Day 24	1300	94	7.23%	7.8%
Day 11	1412	190	13.46%	13.67%	Day 25	1076	59	5.48%	5.5%
Day 12	1319	113	8.57%	9.70%	Day 26	1162	98	8.43%	10.0%
Day 13	1058	106	10.02%	10.21%	Day 27	1214	122	10.05%	10.7%
Day 14	1143	121	10.59%	12.77%	Day 28	1368	127	9.28%	9.7%
-	Total 16858	Total 2140	Average 12.61%	Average 14.66%	-	Total 17163	Total 1408	Average 8.09%	Average 9.0%

The table shows the changes after using the PDCA cycle. Before, the average defect rate was 12.61% with 16,858 units produced in 14 days. After PDCA, the defect rate dropped to 8.09% and production rose to 17,163 units. This proves the steps helped reduce defects and improve output. The comparison is shown in Figure 11.

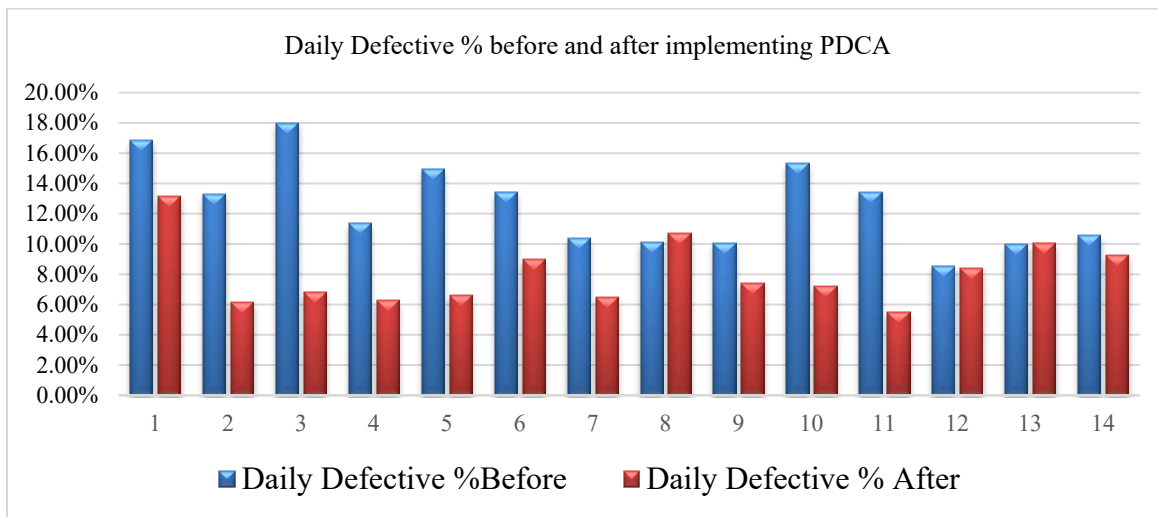


Figure 11. Daily defective% before and after implementing PDC

Figure 12 shows the before and after average DHU%.

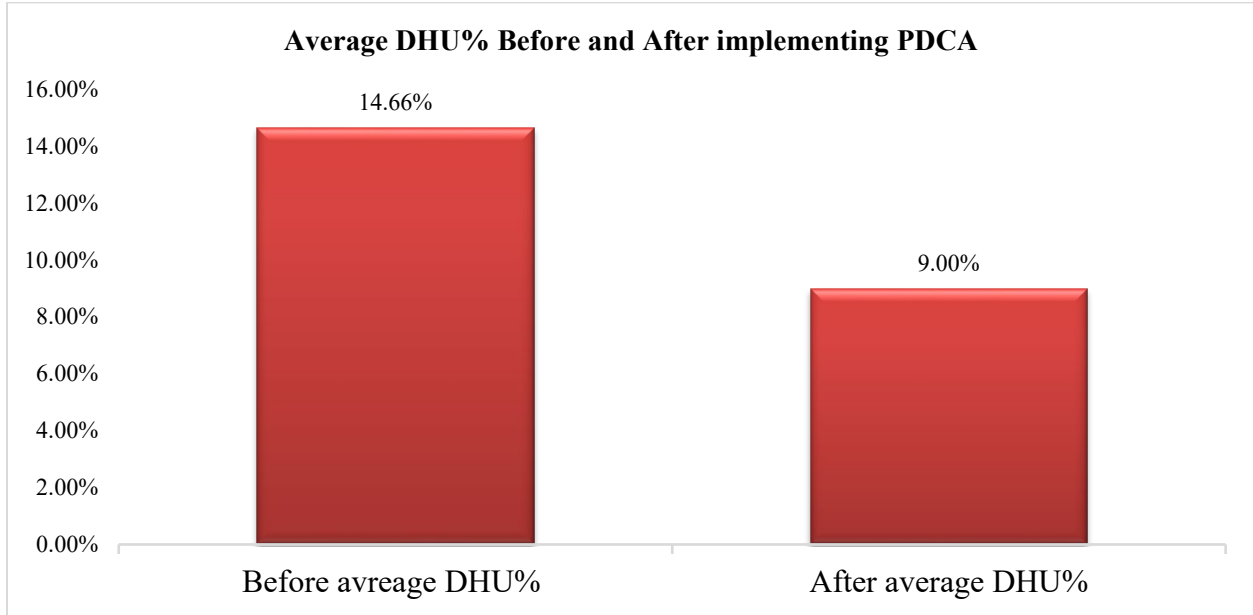


Figure 12. Average DHU% before and after implementing PDCA

The PDCA approach reduced defects from 2,472 to 1,566 while production rose from 16,858 to 17,163, proving flaws were lowered without harming capacity (Table 9).

Table 9. Before and after specific defects occurrence comparison

Specific Defects	Before implementing PDCA			After implementing PDCA			Defects reduction percentage
	Total Production	Occurrence	Occurrence %	Total Production	Occurrence	Occurrence %	
Broken Stitch	16858	452	2.68%	17163	304	1.77%	34%
Raw Edge		378	2.24%		259	1.51%	33%
Uncut Thread		311	1.84%		227	1.32%	28%

The drop in specific defects shows the treatments worked. Broken Stitch fell from 2.68% to 1.77% (34% reduction) due to better training, needle repair, and machine calibration. Raw Edge decreased from 2.24% to 1.51% (33% reduction) with improved machine settings and thread control.

5.3 Proposed Improvements

Although the overall results were positive, some defects like down stitch and hole-missing did not improve as much as others. This shows that more investigation is needed to understand the real reasons behind these specific problems. Also, to keep the improvement steady, the company must continue regular maintenance, provide proper training, and do frequent evaluations. The findings show that using the PDCA cycle not only increases product quality but also

helps maintain or even improve productivity. However, keeping these improvements for the long term will require active training, proper machine maintenance, following standard procedures, and continuous checking. The quality team's use of the 5WH method played a big role in identifying the true root causes of defects. By asking focused questions for each type of defect, the team was able to apply more accurate and effective solutions.

6. Conclusion

This study employed the PDCA framework to reduce sewing defects in linen shirt production, and all research objectives were successfully achieved. The total number of defects came down from 2,472 to 1,566, and the average defect rate also reduced from 12.61% to 8.09%. At the same time, the DHU percentage dropped from 14.66% to 9.00%. As we can see that improving quality didn't reduced quantity as production output increased from 16,858 units to 17,163 units. Common defects like Broken Stitch and Puckering were reduced a lot, which suggests that operator training, regular machine maintenance, and better process control played an important role. The main limitation is that the study was done on one product line and for only 14 days, so long-term results were not measured. Manual data collection may also have small errors. Even with these limits, the research proves PDCA is a useful and practical method for garment factories. The unique contribution is showing how PDCA can be applied in Bangladesh's RMG sector with real data, giving a model that other factories can follow for continuous improvement.

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