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Investigating Root Causes of Sewing Defects Using TQM Tools for Quality Improvement in the Knit Garment Industry

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ABSTRACT

To increase customer satisfaction in the highly dynamic and competitive apparel industry, it is essential to manufacture garments of superior quality. The study aimed to investigate the underlying causes of sewing faults and offer solutions for enhancing quality to a 100% export-oriented knit garment industry in Bangladesh. The study employed a comprehensive approach using quantitative and qualitative research methods to evaluate garment faults systematically. The whole garment inspection procedure was done on five common garment styles to collect the quantitative data. Some novel TQM (Total Quality Management) tools, Pareto analysis, WH questionnaire, cause-effect diagram, and a highly potential focus group panel were employed. The findings indicate the most prevalent faults like an open seam, skip stitch, and label mistake, accounting for 50 per cent, 29 per cent, and 7 per cent of all observed defects, respectively, and their remedies. The research's significance lies in its holistic approach to quality improvement in the knit garment manufacturing industries. This study provides a valuable framework for enhancing product quality and reducing rejection rates by pinpointing crucial defects, their origins, and effective remedies.

KEYWORDS

sewing defects, knit garment industry, quality control, Total Quality Management

INTRODUCTION

In the highly competitive realm of apparel manufacturing, preserving superior garment quality is imperative for longevity and achievement to be competitive. In light of the dynamic nature of global economic conditions, the garment sector increasingly recognizes the need to prioritize superior product quality as a pivotal driver for better customer satisfaction. Several studies shouted for the quality improvement of sewn products for the higher satisfaction of both customers and manufacturers [1-3]. Defects-free production is vital for efficient garment manufacturing [4]. It is expected that the rejections should be as minimal as controlled during production. No ready-made solution can lower the defect per cent quickly. Systematic assessment of each defect and its source and solution should focus on improving quality and productivity [5,6]. This study focused on a 100% export-oriented apparel manufacturing sewing section. A thorough investigation of the sewing faults

identified their intensity in the studied sewing section. The root causes of crucial defects and their possible remedies were reported through discussions with a relevant and highly potential focus group panel.

LITERATURE REVIEW

Bangladesh's garment industry has become a household name because of globalization. The garment industry in Bangladesh has attracted the attention of several large firms from industrialized nations. Reasons for investment include a competent workforce, a desirable labour market, and a convenient location. Bangladesh now has more than 4,500 clothing industries [7]. Regarding ready-made garment exports, Bangladesh is the world's second exporter. More than 150 nations have received ready-made clothing with a "Made in Bangladesh" label. The apparel sector of the Bangladeshi economy accounts for 15% of GDP [8]. A study highlighted the challenges faced by garment manufacturers, including the lack of structured quality control procedures, reliance on informal root cause analysis methods, limited access to education and training opportunities for workers, a deficiency in fostering a culture of continuous learning, limited capabilities in quality control practices, a lack of cross-functional teams, insufficient adoption of contemporary technologies, an inability to respond to change among workers, and ineffective systems for evaluating performance [9]. The implementation of quality management principles has significantly contributed to the achievements of numerous industries and is widely adopted by companies on a global scale [10]. Solution-based guidelines are a piece of an organization's regular working technique, item development, and accumulating arrangement [1]. Moreover, considering its position in the global clothing market, the emerging economy, and geographical position, the apparel industry of Bangladesh needs proper guidelines for quality improvement [11]. Defects that are discovered after sewing have a detrimental impact on the costs of manufacturing [12]. It has several advantages to finding an error early on, before it interferes with other procedures or makes it more challenging to remove seams and re-sew [5]. Researchers also mentioned that minor sewing errors can translate into substantial economic losses and reputational damages, which can be addressed by quality management [13,14]. In a clothing venture, the defects are needed for the characterization according to their deformities. According to the quality and looks of the garment, defects are separated in 3 (three) ways I) Critical, II) Major, and III) Minor [15]. Deformities may happen in the clothing industry caused primarily by non-sewing faults. The following is a list of potential causes of non-sewing defects:

- Defects result from the improper design being used to cut the materials, lining, or interlining.
- The use of defective raw materials is to blame for the defect.
- Defects that occur due to incorrect marking and incorrect spreading.

- Imperfections caused by oil stains.
- Flaws result from improper ironing, folding, packing, or packaging [16].

On the other hand, defects due to difficulties of stitching and seam formation are called sewing defects. These forms of problems develop on the sewing floor while sewing the fabric. Some defects are responsible for clothing rejection, and some can be rectified [15,16]. For instance, non-rectifiable defect needle cuts [17,18] and rectifiable defect missed stitches [13,14].

An efficient method for conducting a remedial and complete system-based evaluation of major faults is conducting a root cause analysis. Thus, root cause investigation is valuable for defining the underlying cause of errors in any manufacturing process, notably garment manufacturing. Using a cause-and-effect diagram helps pinpoint vulnerable spots in a product. The cause-and-effect diagram identifies the causes of certain flaws and contributing variables. It also helps to determine defect reduction tactics, develop an action plan, and measure its efficacy [19]. The application of Pareto analysis in defect analysis demonstrates that a small number of critical defects are responsible for most problems observed in the manufacturing process. MA Samad et al. detected the critical faults that skipped stitch, unclean spots, uncut threads, raw edge out, open seam, crease, top stitch, and damaged stitch through Pareto analysis [20]. The cause-effect diagram determines the sources of vital faults. The root reasons encompass various issues, such as inadequate handling procedures, machinery malfunctions, operator inefficiency, substandard materials, and insufficient training. Solutions were advised for each underlying reason, including the utilization of appropriate needle sizes, the provision of operator training, the enhancement of machine maintenance practices, and the improvement of work processes. By effectively identifying and addressing underlying factors that contribute to challenges and by following suggested strategies and measures, the industry can significantly improve its competitive position within the global market [20,21]. The cause-and-effect diagram depicts the root causes of production flaws. It begins by implementing a few primary fixes within reach, therefore mitigating the problems to the greatest extent feasible [21-23]. A cause-and-effect diagram and Pareto analysis determined the most critical factors in the stoppage losses at a Bangladeshi textile mill [24]. H. Kurnia et al. focused on enhancing the quality of socks within the garment sector by employing the Six Sigma methodology. The study used the DMAIC (Define, Measure, Analyze, Improve, Control) technique to tackle the issue of flaws in sock manufacturing. The research employs analytical tools such as Pareto diagrams, Fishbone diagrams, and Design of Experiment (DoE) to discover prevailing problems and their underlying causes [25].

This research aims to suggest improvements to quality control methods. Therefore, a complete evaluation of the study's implications requires the development of specific recommendations and implementations based on the study's findings. In sum, the research makes an essential addition to

the existing body of knowledge on quality management in the garment industry, especially in countries like Bangladesh, where this sector is crucial to the national economy.

EXPERIMENTAL

Materials and Methods

Quality assessment in this study was conducted in several steps, fault identification, remedial paths identification, and improvement suggestions. The researchers collected the garment defect data from the sewing line of that factory, “AAA Knitwear Limited”, as the sewing section is the most critical in the apparel manufacturing process. After fault identifications, the Pareto analysis was done to identify the most occurring faults. A focus group discussion with potential focused group members (factory production and quality experts) was conducted to identify the causes of crucial faults and their potential remedies using WH questionnaires. Cause-effect diagrams were prepared to identify root causes for four 4Ms factors (Man, Machine, Material, and Method). These cause-effect diagrams and corresponding remedies act as a guideline for quality improvement. Figure 1 represents the research framework of this study.

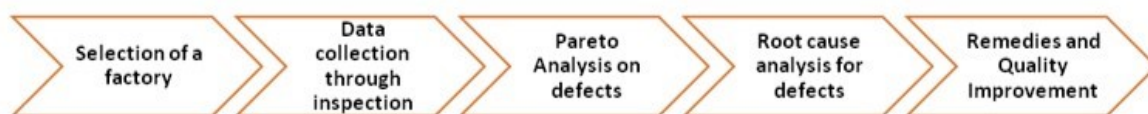


Figure 1. The research framework of the study

Factory Selection and Data Collection

The selected factory was a 100% export-oriented knit garments producer in Bangladesh. Five (5) different styles of garment were selected for this study. The reason for selecting these styles is that these are the standard type of styles the factory produces. The whole garment inspection procedure was followed here. Table 1 represents the garment detail information, including garment type, colour, fabric type, GSM, and sewing line information.

Table 1. Material (Garment) Information

Style No.	1	2	3	4	5
Material (Garment) Information	Style: Basic T-Shirt Colour: White (Chest Print) Fabric type: Single jersey (100% Cotton) GSM: 130	Style: Marl Vest Color: Blue(Steel) Fabric Type: Single Jersey (60% cotton, 40% Polyester) GSM: 160	Style: Cami Colour: White Fabric Type: Single Jersey (100% Cotton) GSM: 120	Style: Polo-Shirt Colour: White (Chest Print) Fabric Type: Pique Fabric (63% Cotton, 37% Polyester) GSM: 200	Style: Long Sleeve T-Shirt Color: Blue(Prussian), Chest Print Fabric Type: Single Jersey (60% Cotton, 40% Polyester) GSM: 160
Garment visual appearance					
	Size: Medium	Size: Small	Size: Medium	Size: Extra Large	Size: Large
Sewing line identification	Sewing Line: C	Sewing Line: D	Sewing Line: E	Sewing Line: I	Sewing Line: B

The selected five styles were inspected at the end of each sewing line. During this inspection, the researchers followed the sewing line and sewing line-end quality issues of the operating procedure for quality control by Moin CJ et al. [26]. One hour of production of each style was inspected, and data was recorded by following the steps in Figure 2. Table 2 presents the Style-wise inspection report of 5 (five) styles for 1 (one) hour of production. The defects location of five styles for one-hour production were also identified and presented in Table 3.

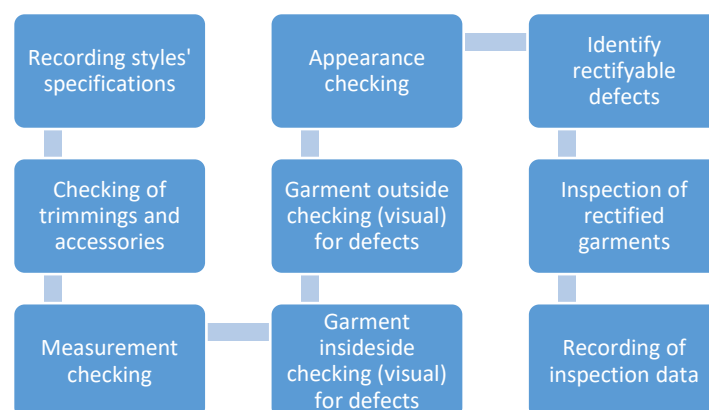


Figure 2. Inspection steps in this study

Table 2. Style-wise inspection chart of 5 (five) styles for 1 (one) hour production

Styles	Cami	T-shirt	Polo Shirt	Marl Vest	Long sleeve
Hours 	(9-10) am	(10-11) am	(11-12) am	(2-3) pm	T-Shirt(3-4) pm
Observation 					
Total Inspected Quantity in pcs	215	103	123	215	102
Total pass goods in pcs	200	100	120	205	100
Altered Quantity in pcs	15	3	3	10	2
Altered Rectified Quantity in pcs	10	3	3	10	2
Reject Quantity in pcs	5	0	0	0	0
Total Accepted Quantity in pcs	210	103	123	215	102

Table 3. Defects found in one-hour production for 5 styles

Defects Location 	Style Name with an hour				
	Cami	T-shirt	Polo Shirt	Marl Vest	Long sleeve
	9-10 am	10-11 am	11-12 am	2-3 pm	T-Shirt3-4 pm
	Defect name with frequency				
Side Seam	Open seam (4)	Open seam (2)			
Bottom Hem	Skip stitch (3)		Skip stitch(1)	Open seam (4)	
Tuck (Bow)	Open seam (3)				
Label joining	Open seam (2)		Label mistake(1)	Label mistake(3)	Label mistake(1)
Tuck (neck+ arm)	Open seam (3)			Open seam (4)	
Neck joining	-	Skip stitch(1)	Skip stitch(1)	Open seam (3)	
Armhole joining					Open seam (1)

The Inspection Reports on one-day production of five styles were collected and summarized according to identified faults and their location. A combined report of all styles with defect name and locations are presented in Table 4.

Table 4. Combined report of five styles with defect names and locations

Defects Name 	Defect Location											
	Neck joining	Armhole joining	Shoulder joining	Placket joining	Side seam	Tuck(Neck+arm)	Bottom Hem	Label joining	Front part	Back part	Sleeve Hem	Tuck (Bow)
Skip Stitch	158	148	56	11	93	0	209	6	0	0	19	0
Open Seam	137	165	97	1	213	267	112	121	0	0	2	106
Broken Stitch	65	2	2	3	2	0	11	0	0	0	2	0
Needle Mark	0	0	1	0	1	0	0	0	0	0	0	0
	Defect Location											
Total	700	1221	87	2								

Defects Name ↓	Neck joining	Armhole joining	Shoulder joining	Placket joining	Side seam	Tuck(Neck+arm)	Bottom Hem	Label joining	Front part	Back part	Sleeve Hem	Tuck (Bow)	Total
Label Mistake	0	0	0	0	0	0	0	172	0	0	0	0	172
Spot	0	0	0	0	0	0	0	3	54	66	0	0	123
Damage	0	0	0	0	0	0	0	0	22	28	0	0	50
Over Stitch	0	0	0	0	0	95	0	0	0	0	0	0	95
Uneven Width	0	0	0	0	0	0	0	9	0	0	0	0	9
Uneven Loop	3	0	0	0	0	0	0	0	0	0	0	0	3
Uneven Point	0	0	0	0	3	0	0	0	0	0	0	0	3
Total Defects= 2465													

Pareto Analysis

Pareto is a graphical representation that displays problems according to their frequencies. The number of difficulties that occur most frequently is listed first, followed by those that occur least frequently. It's a bar chart with a line graph added on top, where the bars show the data in decreasing order, and the line shows the sum of everything. It is one of the seven Total Quality Management tools [3,24]. The Pareto analysis of the defect of 5 styles is shown in Figure 3.

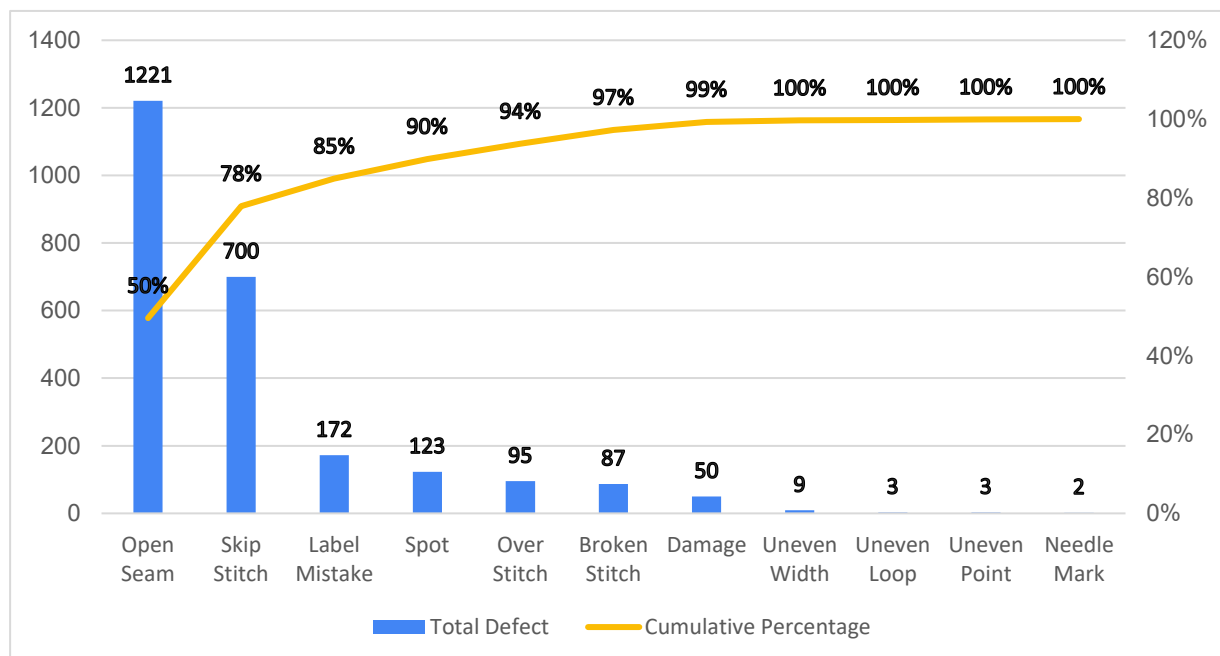


Figure 3. Pareto Chart for defects analysis

Figure 3 shows that among all the defects, Open seam, Skip Stitch, and Label mistakes are the major occurring defects as those have more defect percentage values. The Pareto analysis also shows that these three contribute 85% of total defects. The most occurring defects are shown in Figure 4.

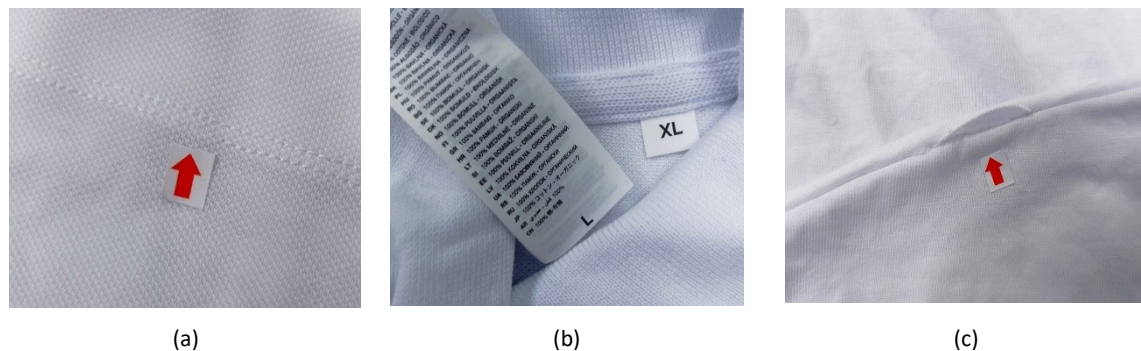


Figure 4. Three mostly occurring defects (a) Skip stitch; (b) Label Mistake; (c) Open Seam

Root cause analysis for defects

The researcher used Cause-effect diagrams to investigate the fundamental causes of the defects. Cause-effect diagram, also known as a fishbone diagram or Ishikawa diagram, is a visual instrument that aids in identifying and comprehending a problem's underlying causes. By systematically analyzing the potential causes, the researchers could understand the factors contributing to the defects. This analysis would serve as the basis for devising targeted solutions to the identified problems. The steps to the root cause analysis are given in Figure 5.

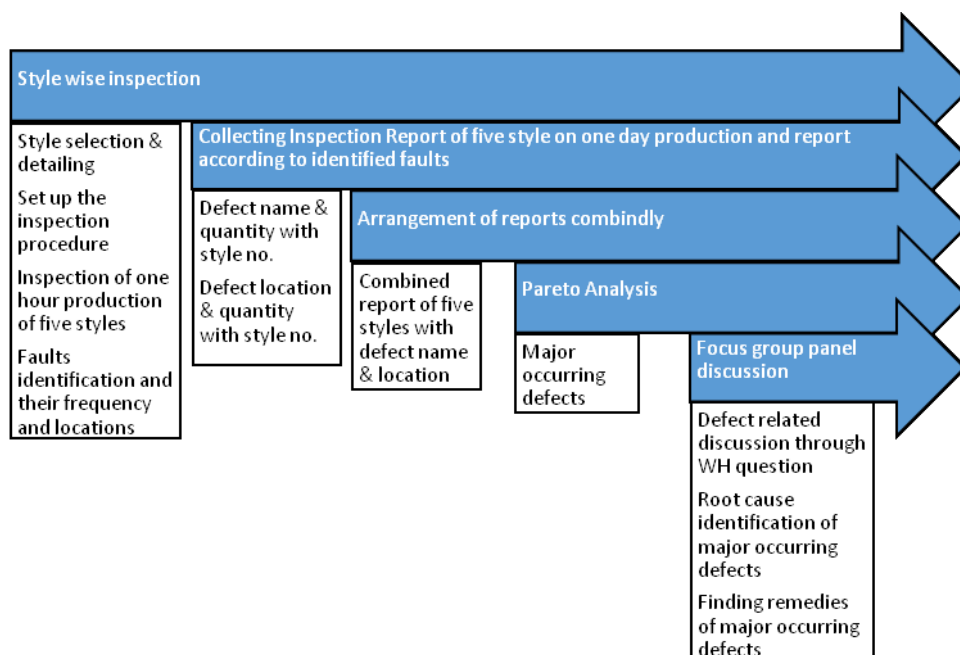


Figure 5. Steps to Root Cause Analysis

The researchers hoped to obtain first-hand information and experiences regarding defects by participating in the focus group. This qualitative information would be indispensable for formulating strategies to enhance quality control practices. The Focus group included members who were experts in sewing operations, and the sewing defects, their causes, and remedies were discussed with them. In addition, the research team employed WH (Who, What, When, Where, Why, and How) questionnaires to collect data and insights from the focus group. Members of the focus group were engaged in two sections. Their designations were:

- Quality-Related People: Quality Manager, Quality In-charge, Senior Quality Inspector, Buyer Quality Inspector, Quality Supervisor, Sewing Line Quality inspector, Sewing Line end Inspector, Spot Remover.
- Production Related People: Production Manager, Production Line In-charge, Production Line supervisor, Maintenance Personnel, Machine Operator.

Contribution of Focus Group:

- Root cause identification of major occurring defects by WH question, which contributes to preparing cause-effect diagrams.
- Defects remedial discussion through WH questions, which contribute to identifying potential remedies for crucial defects.

The WH questionnaires assisted in elucidating the perspectives of production and quality control personnel involved in the sewing process. Tables 5, 6, and 7 show the WH questions of the open seam, skip stitch and label mistakes. Cause and Effect Diagrams of the open seam, skip stitch, and label mistakes have been shown in Figures 6 to 8, along with corresponding WH questions.

WH questions and Cause-effect Diagram of Open Seam

Table 5. WH Question for Open Seam

1. How operator is responsible?	Lack of proper skill, Unable to incorporate new system, unable to align plies properly
2. Where is the fault more?	Feed dog
3. What was the methodological problem?	The tension of sewing thread, stitching method, and incorrect threading
4. Which material is responsible for the open seam?	Weak Thread

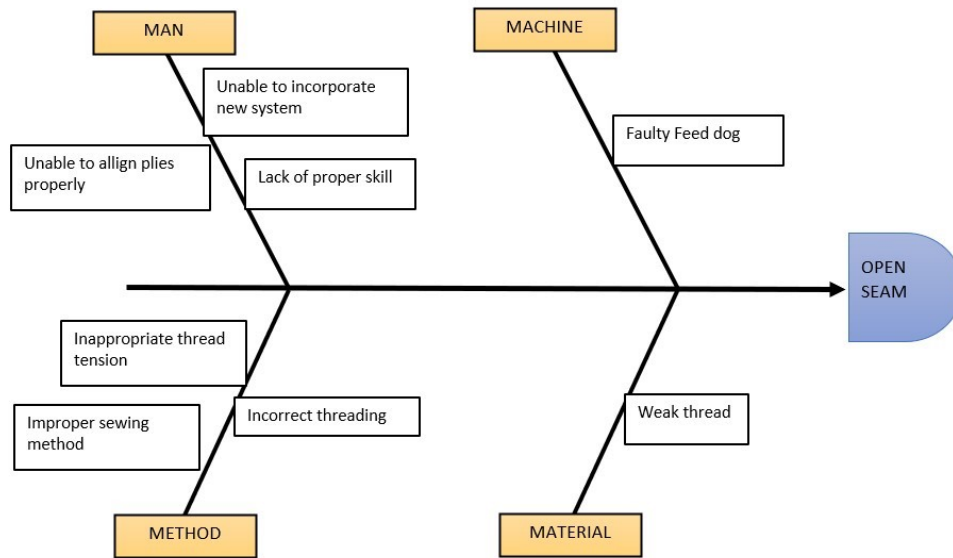


Figure 6. Cause-effect Diagram of Open Seam

WH questions and Cause-effect Diagram of Skip Stitch

Table 6. WH Question for Skip Stitch

1. How operator is responsible?	Tightly holding the fabric, Operator turnover, ergonomic of workstation
2. Where is the fault more?	Improper SPI, worn outside, path, eyelet
3. What was the methodological problem?	Improper thread, long-length stitching
4. Which material is responsible for the open seam?	Weak sewing thread

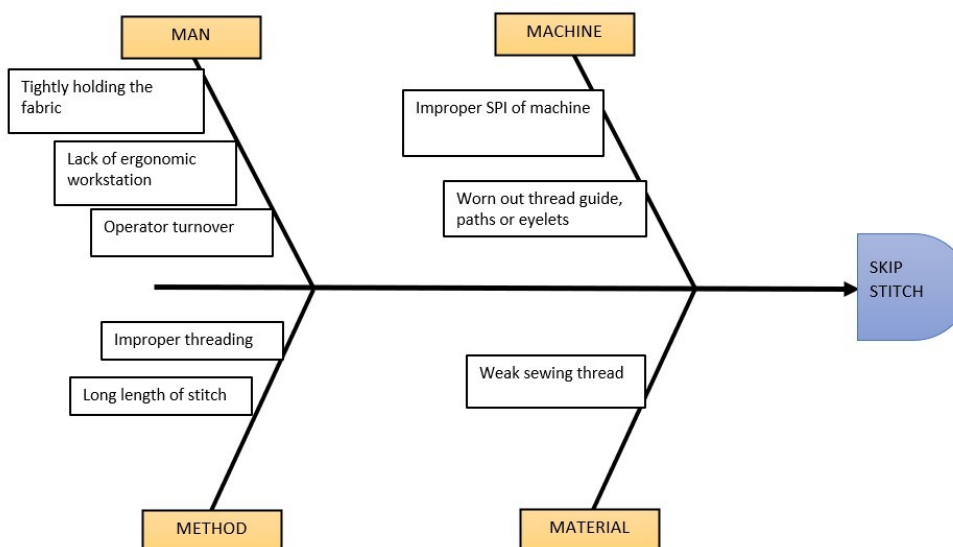


Figure 7. Cause-effect Diagram of Skip Stitch

WH questions and Cause-effect Diagram of Label Mistake

Table 7. WH Question for Label Mistake

1. How operator is responsible?	Lack of observation, indifferent nature
2. Where is the fault more?	Improper timing, lack of proper speed control
3. What was the methodological problem?	Improper Label Inspection Method
4. Which material is responsible for the open seam?	Incorrect labelling

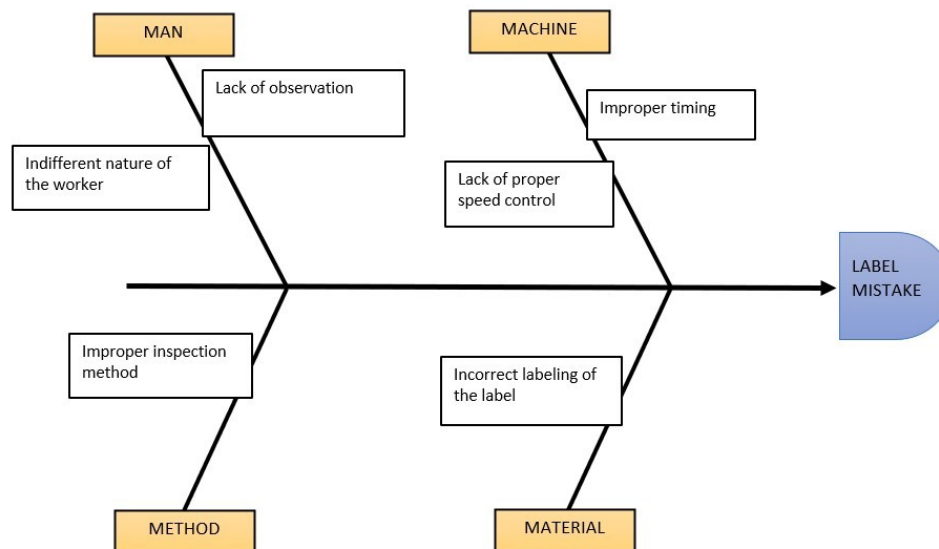


Figure 8. Cause-effect Diagram of Label Mistake

Remedies of Defects

A focus group discussion was also done to discover potential remedies through the WH question. The answers to WH questions from the Focus group are reported in Table 8.

Table 8: Defects Related Discussion of remedies through WH question with Focus Group

Open Seam	Skip Stitch	Label Mistake
1. What needs to be done? Ans: Checking needles, re-altering the string pressure, tension should be quantifiable, Reset standard, Re-altering presser foot weight before sewing.	1. What needs to be done? Ans: Checking the needles, replacing needles, changing needle size, modifying presser foot pressure, Re altering the string tension.	1. What needs to be done? Ans: Checking the needles, checking the labels to see if it is mixed or not, the same size is on the same bundles, modified presser foot pressure, encouraging the workers to be mindful.
2. How much is needed to be done? Ans: Goal to reach zero defect	2. How much is needed to be done? Ans: Goal to reach zero defect	2. How much is needed to be done? Ans: Goal to reach zero defect

Open Seam	Skip Stitch	Label Mistake
3. Where it is needed to be done?	3. Where it is needed to be done?	3. Where it is needed to be done?
Ans: In every stitch on the seam line.	Ans: In every stitch on the seam line.	Ans: In every bundle.
4. Who should do it?	4. Who should do it?	4. Who should do it?
Ans: The operator should do it.	Ans: The operator should do it.	Ans: The operator should do it.
5. When is it needed to do?	5. When is it needed to do?	5. When is it needed to do?
Ans: During sewing.	Ans: During sewing.	Ans: During bundling and attaching.

RESULTS AND DISCUSSION

Most Occurring Defects:

The pie chart in Figure 9 shows all the defect percentages, open seam 50%, skip stitch 29%, label mistake 7%, spot 5%, Broken stitch 3%, Damage 2%, Uneven width 1%, and others were less than 1%. This study found an open seam, skip stitch, and label mistakes as the most occurring defects. These defects are the primary threat to maintaining the acceptable quality of the products. The other defects are also responsible for assuring the quality of the garments, but according to the percentage of the defects, those may be considered minor threats.

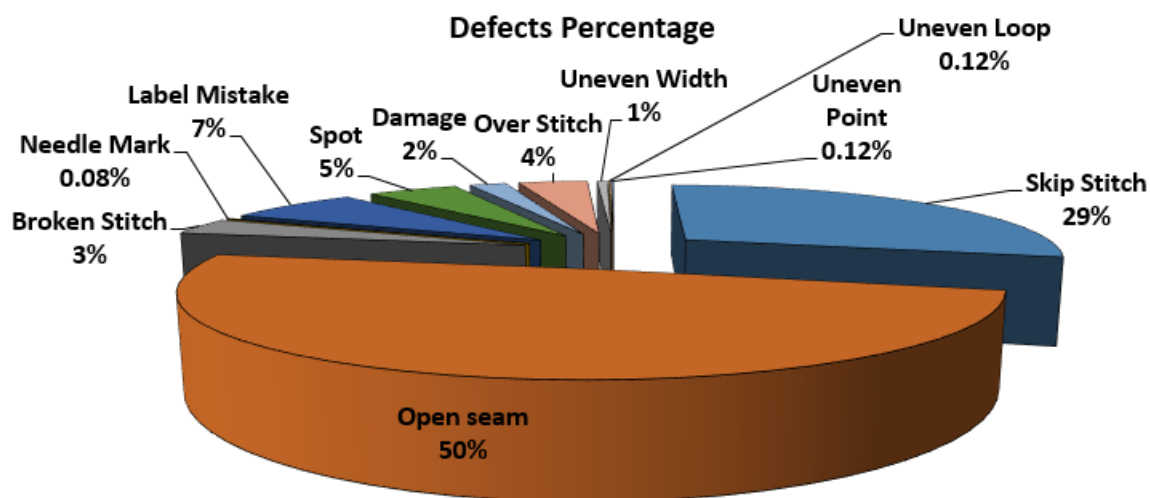


Figure 9. Different types of defect percentages for five styles

Remedies of Most Occurring Defects

Remedies of the most occurring defects were found through discussion with the focus group and analyzing the cause-effect diagram of each one.

Remedies of Open Seam

1. Make sure the needles are correctly inserted and positioned to be replaced.
2. Adjust the tension of the strings again before stitching.
3. Return to default and use a run method to double-check the ring configuration.
4. Changing the weight of the presser foot before stitching.
5. Tension should be quantifiable.
6. The needle and hook must be appropriately positioned and timed.
7. Delineated guides for stitching.

Remedies of Skip Stitch

1. Check that the needles are correctly inserted and set.
2. Proper machine autonomy and timings.
3. Swap out the needle.
4. Adapt the needle size to the string size.
5. Re-alter presser foot weight before sewing.
6. Modifying the presser foot pressure.

Remedies of Label Mistake

1. Operators should be mindful while bundling the label.
2. Re-alter the presser foot weight before attaching the label.
1. Check the stitches properly during label attaching.
3. Mixing of the label should be avoided.

Quality Improvement Suggestions

Sewing is one of the most essential processes in the apparel industry, so defects are prevalent. However, it is vital for quality improvement to identify the crucial defects, their location, probable causes, and potential remedies. The study identified the crucial defects, locations, probable causes, and potential remedies by systematically implementing some TQM tools and discussing them with highly potential focus group members. The study framework encompasses a range of methods to detect and resolve sewing imperfections, including open seams, skip stitches, and mistakes in labelling. The findings of the inquiry indicated that the most often occurring flaws, namely open seam (50 per cent), skip stitch (29 per cent), and label problems (7 per cent), accounted for a significant fraction of the total number of defects detected, which amounted to 2465. Whereas Broken stitch, Open seam, Pleat, Skip stitch, and Label missing defects are highly crucial for another 100% export-oriented industry in Bangladesh and are suggested for the implementation of continuous improvement [21]. A

similar attempt by MA Abtew et al. showed that the implementation of Statistical Process Control (SPC) techniques led to notable enhancements and was demonstrated by a reduction in the rejection rate from 9.141% to 6.4% within four months [3]. So, implementing the suggested recommendations of the study could significantly reduce the rejection of garment manufacturers. The "AAA Knitwear Limited" factory has been the focus of this research, and this can be extended to other apparel manufacturing industries. Moreover, manufacturers can contribute to persistent improvements in quality, productivity, and overall operational efficiency by cultivating a culture that promotes proactive problem-solving, providing frequent training, and refining processes.

CONCLUSION

This study elucidates the crucial significance of quality management and enhancement in the knit garment sector. The research sought to tackle the notable sewing defects that were caused by defective garments and rejections, which have the potential to affect product quality, customer satisfaction, and industry standing. The study identified eleven types of sewing defects in the studied case. Among those defects, three, namely open seam, skip stitch, and label mistake, were crucial and accounted for 85% of the total observed defects. The causes and prospective remedies for these three defects were noted through the discussion with responsible personnel of both the production and quality control departments. The most critical faults differ across the clothing industry. This method can help the knit garment industry to determine the most critical faults, causes, and quality improvements.

Author Contributions

Conceptualization – Moin CJ, Hossain KR and Baral LM; methodology – Moin CJ and Hossain KR; formal analysis – Moin CJ and Hossain KR; investigation – Moin CJ and Hossain KR; resources – Moin CJ and Hossain KR; writing-original draft preparation – Moin CJ and Hossain KR; writing-review and editing – Moin CJ, Hossain KR and Baral LM; visualization – Moin CJ and Hossain KR; supervision – Moin CJ. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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REFERENCES

- [1] Bubonia JE. Apparel quality: A guide to evaluating sewn products. Bloomsbury Publishing; 2014.
- [2] Bheda R, Narag AS, Singla ML. Apparel manufacturing: a strategy for productivity improvement. *Journal of Fashion Marketing and Management*. 2003; 7(1):12-22.
<https://doi.org/10.1108/13612020310464331>
- [3] Abtew MA, Kropi S, Hong Y, Pu L. Implementation of statistical process control (SPC) in the sewing section of garment industry for quality improvement. *Autex Research Journal*. 2018; 18(2):160-172. <https://doi.org/10.1515/aut-2017-0034>
- [4] Bongomin O, Mwasiagi JI, Nganyi EO, Nibikora I. Improvement of garment assembly line efficiency using line balancing technique. *Engineering Reports*. 2020; 2(4):e12157.
<https://doi.org/10.1002/eng2.12157>
- [5] Fatima M, Ahmed E. Quality Management in Pakistan's Readymade Garments' Industry. *Quality Engineering*. 2005; 17(3):459-465. <https://doi.org/10.1081/QEN-200059887>
- [6] Mehta PV, Bhardwaj SK. Managing quality in the apparel industry. National Institute of Fashion Technology; 1998.
- [7] BGMEA. BGMEA at a glance. BGMEA; 2023. Available from:
<https://www.bgmea.com.bd/page/aboutus>
- [8] Mottaleb KA, Sonobe T. An inquiry into the rapid growth of the garment industry in Bangladesh. *Economic Development and Cultural Change*. 2011; 60(1):67-89. <https://doi.org/10.1086/661218>
- [9] Hoque I. Why suppliers struggle to deliver defect-free products to buyers: a buyer–supplier dyadic perspective. *Journal of Fashion Marketing and Management*. 2022; 26(5):852-869.
<https://doi.org/10.1108/JFMM-05-2021-0129>
- [10] Parveen I, Mia MA, Ali MS, Rafsun-UI-Hasan K, Rahman MM, Mahmud MI, Cho HM. Implementation of JIT to increase productivity in sewing section of a garment industry. In: *Proceedings of the International Conference on Industrial Engineering and Operations Management Bangkok, Thailand, March 5-7, 2019*. p. 618-629.
- [11] Hossain KR. Analysis of sewing faults in a knit garment industry [thesis]. Daffodil International University; 2019.

- [12] Wook Kang C, Babar Ramzan M, Sarkar B, Imran M. Effect of inspection performance in smart manufacturing system based on human quality control system. *The International Journal of Advanced Manufacturing Technology*. 2018; 94:4351-4364. <https://doi.org/10.1007/s00170-017-1069-4>
- [13] Keist CN. Quality control and quality assurance in the apparel industry. In: Nayak R, Padhye R. *Garment Manufacturing Technology*. Woodhead Publishing; 2015. p. 405-426. <https://doi.org/10.1016/B978-1-78242-232-7.00016-3>
- [14] Choudhary AK, Sikka MP, Bansal P. The study of sewing damage and defects in garments. *Research Journal of Textile and Apparel*. 2018; 22(2):109-125. <https://doi.org/10.1108/RJTA-08-2017-0041>
- [15] Ashik MAR, Afraid S, Kaiser SM. Thesis report on Frequently Occurred Sewing Defects & Their Remedies [thesis]. Daffodil International University; 2013.
- [16] Tyler DJ, editor. *Carr and Latham's technology of clothing manufacture*. John Wiley & Sons; 2009.
- [17] Gu X, Cui L, Qiu Y. Design and Analysis of Fabric Sewing Damage Detection Equipment. In: 2022 3rd International Conference on Intelligent Design (ICID) 2022 Oct 21. IEEE; 2022. p. 200-203. <https://doi.org/10.1109/ICID57362.2022.9969736>
- [18] Aychilie DB, Kyosev Y. Sewing needle heating: A review on the research regarding causes, effects and methods for its reduction. In: *AIP Conference Proceedings* 2022 Jan 24. AIP Publishing; 2022. <https://doi.org/10.1063/5.0077068>
- [19] Wilson PF, Dell LD, Anderson GF. *Root cause analysis: A tool for total quality management*. American Society for Quality; 1993.
- [20] Samad MA, Rahman CL, Rahman MT, Islam MS, Sarkar P. Measurement & Analysis of Productivity and Finding Solutions to Improve Productivity in a Garment Factory in Bangladesh. *International Journal of Engineering and Advanced Technology*. 2018.
- [21] Kapuria TK, Rahman M, Haldar S. Root cause analysis and productivity improvement of an apparel industry in Bangladesh through kaizen implementation. *Journal of applied research on industrial engineering*. 2017; 4(4):227-239.
- [22] Özeren F, İlhan İ. A statistical process control application for sewing faults in men's suit production. *Tekstil ve Konfeksiyon*. 2011; 21(4).
- [23] Lee CKH, Choy KL, Ho GTS, Chin KS, Law KMY, Tse YK. A hybrid OLAP-association rule mining based quality management system for extracting defect patterns in the garment industry. *Expert Systems with Applications*. 2013; 40(7):2435-2446. <https://doi.org/10.1016/j.eswa.2012.10.057>
- [24] Hossen J, Ahmad N, Ali SM. An application of Pareto analysis and cause-and-effect diagram (CED) to examine stoppage losses: a textile case from Bangladesh. *The Journal of the Textile Institute*. 2017; 108(11):2013-2020. <https://doi.org/10.1080/00405000.2017.1308786>

- [25] Kurnia H, Jaqin C, Purba HH, Setiawan I. Implementation of Six Sigma in the DMAIC Approach for Quality Improvement in the Knitting Socks Industry. *Tekstil ve Mühendis*. 2021; 28(124):269-278.
- [26] Moin CJ, Sohail ud Doulah ABM, Ali M, Sarwar F. Implementation of an operating procedure for quality control at production level in a RMG industry and assessment of quality improvement. *The Journal of the Textile Institute*. 2018; 109(4):524-535.
- <https://doi.org/10.1080/00405000.2017.1358412>