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Minimization of Defects in the Sewing Section of a Garment Factory through DMAIC Methodology of Six Sigma

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Abstract

The fast changing economic conditions such as global competition, declining profit margin and customer demand for high quality product at low cost push the manufactures to reduce their production cost without compromising quality in order to survive in business arena. Defects minimization is the first condition of reducing production cost and improving the quality. It will also reduce the cycle time by reducing reworks and finally result higher productivity. Concerning this matter, the present study explores the use of DMAIC methodology of six sigma to minimize the defects rate in a selected garment factory. This is a systematic approach towards defects minimization through five phases of DMAIC methodology named define, measure, analyze, improve and control. Different six sigma tools were used in different phases. Pareto analysis was done to identify the major types of defects. Root causes of those defects were detected by cause and effect analysis. Finally some potential solutions are suggested to overcome those causes. The result found after implementation of the solutions is very significant. The defect percentage has been reduced from 12.61 to 7.7 and consequently the Sigma level has been improved from 2.64 to 2.9255.

Keywords: Defects, DMAIC, Six Sigma, Sigma level. Productivity.

Introduction

Ready-made garment (RMG) is the most important sector in Bangladesh in terms of foreign exchange earnings, employment, economic advancement and its contribution to Gross Domestic Product (GDP). It is one of the leading exporting industries in Bangladesh. The growth of RMG sector was substantial during last two decades. According to the annual financial report of BKMEA, in the financial year 2012-2013, 79.63% of Bangladesh's export earnings came from the garment industry and its contribution to the GDP was 8.07%[1]. The export-quota system and the availability of cheap labor are the two main driving forces that enable tremendous success of this industry. But, the export-quota free environment after the year 2004 has raised the competitiveness issue of the RMG sector of Bangladesh.

Quality improvement of the product is the key to keep this sector on the track of global competition. India, Indonesia and Sri Lank are the most serious contender of garment industries in Bangladesh. At this critical point, manufacturers should give top priority to reduce defects in their products and become competitive.

As the world financial situation is changing quickly, industries are now giving more focus on customer demand for superior quality product, turnover and enhanced productivity. A study by M.M. Islam and A.M. Khan shows that rejected garments after shipment is very usual in the garment manufacturing industries in Bangladesh and this problem greatly hampers the reputation of our garments industries[2].

According to Tennant and Geoff, A systematic continuous improvement process can largely minimize the defect percentage and increase the productivity[3]. Dr. Sikorski et al. emphasis that in order to achieve the overall objective in minimizing defects and rejection of finished products it is required to set up document and maintain a system able to ensure that products are conformance to the standards specifications[4].

Considering the reasons above, this study makes an attempt to explore the use of DMAIC (define, measure, analyze, improve and control) methodology of six sigma in a selected garment factory to minimize the defect percentage. DMAIC methodology of six sigma is a problem solving method where six sigma tools are used to analyze the process data and finally the root causes behind the defects produce in the product are identified. Six sigma is a quality improvement process of final product by reducing the defects, minimizing the variation and improving capability in the manufacturing process.

A study by Antony et al. indicates six sigma as a more superior level of quality, which will definitely implement those organizations that devoted to business excellence after QMS certification per ISO 9000 series[5]. It is a set of course of action foundation on statistical process control (SPC) that is capable of helping companies to achieve considerable improvement in product quality and hence raise competitiveness. Six sigma initiated from the terms associated with statistical modeling of manufacturing processes. By definition, six sigma is less than 3.4 Defect per Million Opportunities (DPMO) or parts per million (PPM).

Background of the Study: At present Bangladesh economy is mostly dependent on Readymade Garments sector. Several factors such as product quality, production lead time, manufacturing cost etc. are the determinant of the progress of this sector. These vital factors are hindered because of the defects in the products. According to Kolarik, Defects rate causes a direct effect on the profit margin of the product and increase cost of quality during the manufacturing of product[6].

Defects play a vital role in the productivity of the garments factory. If a defect is detected in the final inspection, the defective piece has gone a long way before the defect is detected. The cost of the production process for a defective garment is totally wasted as the product cannot be exported. Sometimes the defective pieces can be made exportable with alterations, but it costs more money, which has no value to a factory owner.

A study by Saroj Bala concluded due to the increasing demand of higher value at lower price, garments producer have to improve their performance through making zero defect product[7].

In a garment factory, defects usually come from the fabric section, cutting section, sewing section or finishing section. Among those the sewing section is the largest and most complex in operation. A study by Kayaalp I. and Erdogan, M. show that more than 75% garment defects are found in the final inspection coming from sewing section[8]. In this context, defect minimization in the sewing section of Readymade Garments factory is selected for this study.

Methodology

The research methodology adopted for this study is case study and brain storming. The case study conducted on a garment factory named "Vision Composite Knit Limited" located at Savar, Dhaka. At first preliminary investigation was carried out at cutting, sewing, washing, finishing and packing section to identify the area where most of the defects are occurred. It is found the sewing section is highly suffered from defect and rework problems. For this reason sewing line is identified in order to conduct research work. The aim of the work is to minimize the defect percentage by using DMAIC approach of Six Sigma methodology.

Secondary data of the sewing section was collected from the management of the factory. The data was collected for Shirt only. According to our observation and using the end line quality data provided by the management we identified some repetitive defects that occur in the sewing section.

The information and data collected were arranged so that further study and analysis could be performed. Two mostly used Six Sigma tools namely Pareto Analysis and Cause-Effect Diagram were used in the analysis part. Pareto analysis was used to identify the top occurringdefects and then Cause-Effect Diagrams were constructed for those defects.

After identifying the major causes of the top occurring defects, corresponding suggestions to minimize the frequency of those defects were provided. The suggestions were made based on the brain storming session which was arranged by the management of the factory. Experts of the factory from different areas were present on that session.

Due to time constraint, management could not be able to implement all of the suggestions together. But they implemented some of the suggestions in short time-frame on their pilot line and found some improvement.

Analysis and Findings: Data Collection: Data sheets were collected for garment item i.e. shirt for the duration of three months. The data had been taken by the end line quality inspectors from two production lines of sewing section. A total of 4670 shirts were checked and 589 pieces were found defective.

Application of Six Sigma DMAIC Methodology: Define Phase: Define is the first phase of the DMAIC methodology of Six Sigma. The purpose of this phase is to define the problem, goal of the project and the process that needs to be improved to get higher sigma level. There are different six sigma tools are available for define phase. Here SIPOC tool was applied.
Problem Statement**:** The garments manufacturer experience high volume of rejections of their products owing to defects.

Goal Statement**:** To decrease the percentage of defect to lowest level and thereby to reduce production cost and increase quality and productivity.

SIPOC**:** This is a process map that includes Suppliers, Inputs, Process, Outputs and Customers. Quality is judged based on the output of a process. Table 1 shows the SIPOC flow of the selected factory.

Table-1
SIPOC Flow of Vision Composite Knit Ltd

Suppliers	Inputs	Processes	Outputs	Customers
-Altex Fabrics Ltd. -Fabian Group	Unstitched cloth Machinery Thread Needles Button Zipper Label	Cutting Sewing Washing Ironing Finishing Packaging	T-shirt Polo-shirt Pant	-C& A -Tesco -Maskos

Measure Phase: At this phase, percentage of defects, existing DPMO (Defect per Million Opportunity) and Sigma Level of the selected factory were calculated which is indicated in table 2. The frequency of defects of the inspected shirts was also

calculated and recorded in table 3. Pareto Chart was used as a Six Sigma tool here.

Table-2
DPMO and Sigma Level of Existing Process

Total Checked pieces	4670
No. of Defectives	589
% Defectives	12.61
DPO	0.126
DPMO	126124
Sigma level	2.64

Table-3
Frequency of Defects of the Inspected Shirts

Defects	Total Occurrence	Percentage (%) of Occurrence
Broken Stitch	137	23.26
Skip Stitch	58	9.85
Down Stitch	48	8.15
Raw Edge	52	8.83
Joint Stitch	41	6.96
Uneven Stitch	51	8.66
Puckering	47	7.98
Hole/Damage	18	3.06
Spot/Oil stain	39	6.62
Reject	11	1.87
Slanted	9	1.53
Uncut Thread	1	0.17
Size Mistake	5	0.85
Process Missing	47	7.98
Reverse	25	4.24
Total	589	100.00

Pareto Chart: Pareto Chart is used to graphically summarize and display the contribution of each type of defect. It is a bar graph. The lengths of the bars represent occurrence and are organized with longest bars on the left and the shortest to the right. In this way the chart visually shows which defects are more significant. By using Pareto Chart major types of defects were identified which is shown in
figure 1. The chart was constructed by using MiniTab Software.

From the Pareto Chart following major sewing defects are identified. i. Broken stitch, ii. Skip stitch, iii. Raw edge, iv. Uneven, Up/Down, iv. Down Stitch, v. Process Missing, vi. Puckering, vii. Joint Stitch

Among all, only these 8 defects are responsible for 81.7% of total defects percentage.

Analyze Phase: The goal of the analyze phase is to go through the data to find out the root causes of the problems and seek improvement opportunities. At the measure phase eight major types of defects were identified and the target of this phase is to find out all the potential causes of those defects. Two problem solving six sigma tools were used at analyze phase and these were: Brainstorming and cause and effect diagram.

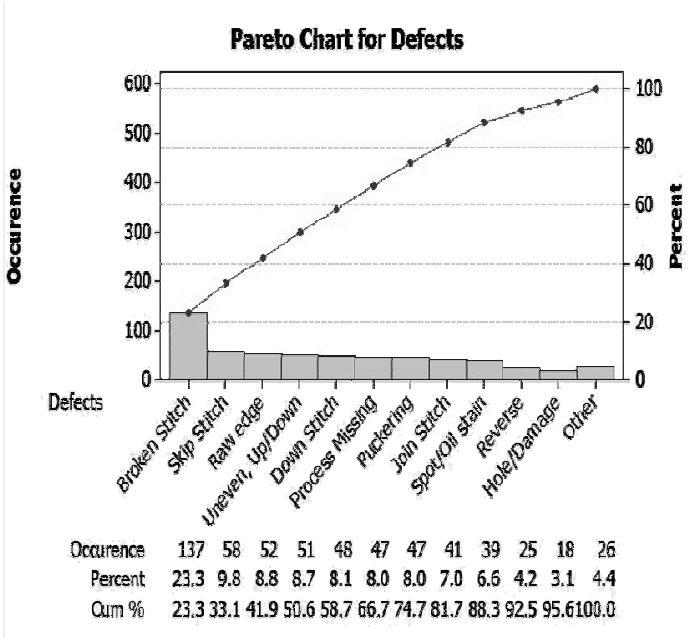

Figure-1
Pareto Chart for Identifying Major Defects

Brainstorming: Brainstorming is one of the most effective problem solving tools. The goal of this tool is to identify the issues, solutions and opportunities. In order to identify the potential causes of the defects and their respective solutions a Brainstorming session was arranged at the selected factory. The session was carried out by Round Robin method with the presence of the following members that is shown in table 4.

Table-4
Attendants at the Brainstorming Session

Attendants	Numbers
Factory Manager	1
Sewing Floor Manager	1
Industrial Engineer	2
GPQ (Growth, Production and Quality)	2
End Line Quality Inspector	3
Line Supervisor	3
Sewing Machine Operator	5

Cause and effect diagram: Through brainstorming with sewing operators, line supervisors, end line quality inspectors, industrial engineers and floor manager, various probable causes were recognized. The potential causes are then identified by online inspections and root cause analysis. Figure 2 shows the cause and effect diagram for all types of defects.

Improve Phase: The purpose of the DMAIC Improve phase is to discover a solution to the problem that the task aims to address. This involves brainstorming potential solutions, selection of

solutions to test and evaluating the results of the implemented solutions. Often a pilot implementation is conducted prior to a full-scale rollout of improvements.

Suggested Solutions: This study tried to suggest some potential solutions to minimize the causes of defects through Brainstorming, direct observation and literature review. The solutions with their corresponding causes are given in table-5.

Implementation of the Solutions: After having discussion with the management, they agreed to implement some of the suggested solutions into one of their pilot sewing lines. This study followed the Kaizen Improvement Technique that means continuous improvement. In order that the solutions are divided into two categories: short term and long term.

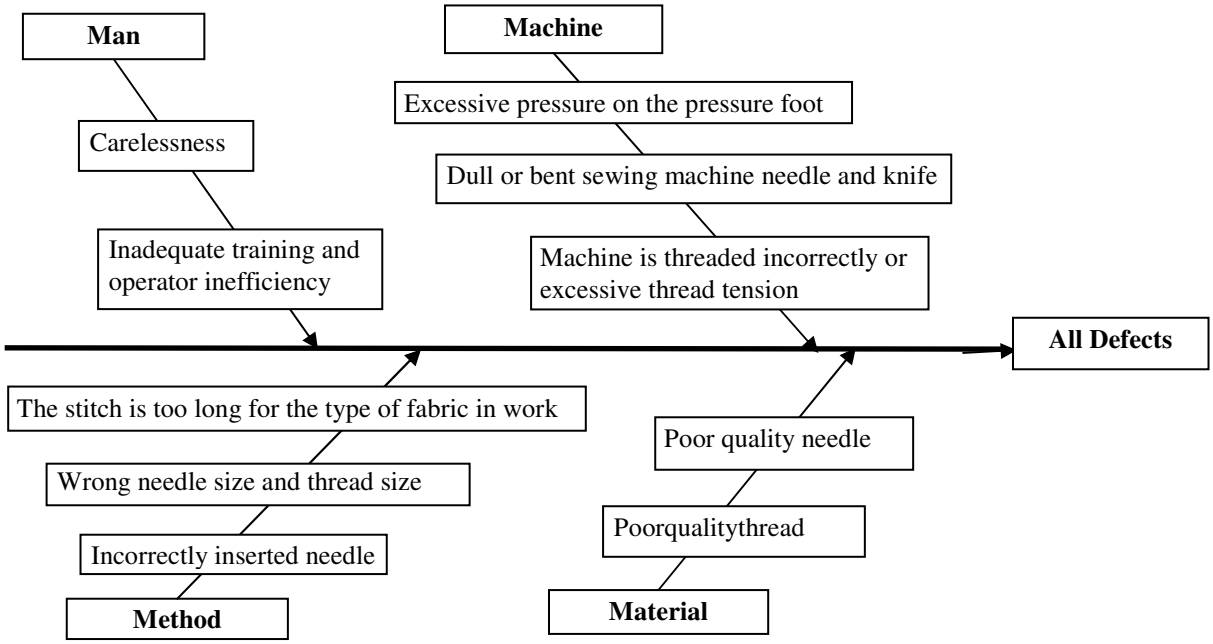

Figure-2
Cause & Effect Diagram for All Major Defects

Table-5
Suggested Solutions for All Major Defects with Corresponding Causes

Areas	Causes	Suggested Solutions
Man	Carelessness	Improve supervision.
	Inadequate training and operator inefficiency	Trained operators sufficiently
Machine	Machine is threaded incorrectly or excessive thread tension	Rethread machine and maintain proper thread tensions. Make sure the thread passes through the tension discs
	Dull or bent sewing machine needle and knife.	Replace the needle and knife with a new one.
	Excessive pressure on the presser foot	Lessen the pressure on the presser foot. Slacken both tensions.
Method	Incorrect size of the needle and thread for operation	The size of the needle and thread should be synchronized. Ensure both the needle and bottom (looper) positions are rightly fed by the correct thread type and size.
	Incorrectly inserted needle	Insert the needle on correct position. Check that the bobbin is wound correctly and no loose threads or loops sticking out.
	Comparatively long stitch for the type of fabric in work.	Shorten the stitch length by means of the stitch regulator, especially when sewing fine fabrics.
Material	Poor quality thread	Use good quality thread.
	Poor quality needle	Use high quality needles from another brand. Needle should have high heat resistance capacity.

First, implement the short term solutions and then gradually go for the long term solution

Short term solutions are: i. Replacement of dull or bent sewing machine needles and knives with new ones. Insert the needles to the correct position. ii. Rethread the incorrectly threaded bobbins. iii. Always use good quality thread. iv. Use proper stitch length (as small as possible) during sewing. v. Carefully follow the marked line during sewing.

Long term solutions are: i. Provide adequate training to the operator. ii. Improve supervision. iii. Change faulty machine parts. iv. Develop a proper quality management system in order to quick detection and solution of the quality problems.

Based on the solutions provided by this study, some corrective actions were taken that is shown in table-6. The implementation was done into one of their pilot sewing line. The pilot line had total 120 sewing machines.

Table-6
Corrective Actions and Its Amount

Corrective Actions	Amount
Replacement of dull or bent sewing machine needles	18 needles
Replacement of dull knives	8 knives
Number of machines rethreaded	20 machines
Correction of needle insertions	13 machines
Replacement of faulty bobbins	3 machines
Training provided	3 hrs each day

Results and Discussion

All short term solutions were implemented into one of their pilot sewing lines. After implementation of solutions percentage of defectives, DPMO and Sigma Level were calculated and reported on table 7.

Table-7
DPMO and Sigma Level after Improvement

Total Checked	6740
No. of Defectives	519
% Defectives	7.7
DPO	.077
DPMO	77003
Sigma level	2.9255

Control Phase: After implementation of the solutions, the progressive outcomes were shared with the management. The main defects were recognized and partially reduced in amount. Now the challenge is to withstand the progresses and refining the system continuously. For this purpose a control plan is prepared.

Control Plan: The management needs to take initiative on the following obligatory activities to withstand the progresses after Six Sigma implementation. i. Arrange training continuously for the garments operators on the issue of quality. ii. Always use good quality threads, needles and other garment accessories. iii. A sound incentive scheme should be taken for high quality performance. iv. Preventing defects will be given more priority than correcting defects. v. Strictquality control should be enforced in line. vi. The organization should develop a proper Quality Management System.

Conclusion

Minimizing defect is very important for ensuring the quality of products. Manufacturing the quality product is mandatory to sustain in this global competitive market. This study follows the DMAIC methodology of Six Sigma in order to find out the major defects, their root causes and then suggests logical solutions in order to minimize those defects. From the Pareto Chart total eight defects (broken stitch, skip stitch, raw edge, uneven stitch, down stitch, process missing, puckering and joint stitch) were identified those were responsible for more than 80% of total defects occurring in the sewing section of the garment factory for the item of shirt. After finding the major defects, brainstorming tool was used to identify the probable causes and then potential root causes were identified by online inspections and root cause analysis.

This study found that the sewing section of selected garment factory was operating at a defect percentage of 12.61. The rate was very high at this present business context. After introducing the DMAIC Methodology of Six Sigma the percentage of defect is decreased to 7.7. There is also found a significant improvement of the Sigma level of the industry. It is shifted from 2.64 to 2.9255. So, this method is very effective to the minimization of defects. As the minimization of defects is a continuous process further implementation of this methodology will help the company enjoying more reduction on defect rate and improvement on productivity.

This study is concentrated only the sewing section, an integrated study of other sections of the factory such as knitting, dying, cutting and finishing can be more effective on the minimization of defects.

Many garment factories in Bangladesh are not conscious about the Six Sigma concepts and this study will start a positive surge across the garment industries and make them more competitive.

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