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Implementation of Six Sigma to Minimize Defects in Sewing Section of Apparel Industry in Bangladesh

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Implementation of Six Sigma to Minimize Defects in Sewing Section of Apparel Industry in Bangladesh

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I. Introduction

The ready-made garment (RMG) is one of the most essential sectors in Bangladesh in terms of foreign export earnings, economic advancement, employment, and its contribution to Gross Domestic Product (GDP). It is one of the leading exporting industries in Bangladesh. To achieve the overall objective in minimizing defects and rejection of finished products, it is required to set up a document and maintain a system able to ensure that products are conformance to the standards specifications. Considering the reasons above, that means this study attempts 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 the final product by reducing the defects, minimizing the variation and improving capability in the manufacturing process. Six Sigma initiated from the terms associated with statistical modeling of manufacturing processes.

a) Objectives

Quality Management is an operational strategy oriented towards achieving the shortest possible cycle time by eliminating wastes. The term Quality Management is coined to represent half the human effort in the company, half the manufacturing space, half the investment in tools and half the engineering hours to develop a new product in half the time. Any industry can achieve these benefits if they religiously follow this concept in their organization. In simple terms, lean manufacturing is without waste. Thus the objective of this study is to find out how we can use Quality Management to achieve the following:

1. To meet customer demand on time by eliminating nonvalue added work from the process.
2. To minimize the work in process inventory.
3. To create the flexibility of style changeover.
4. To reduce rework percentage.
5. To create a pool of multi-skilled operators who can respond quickly for changing the style.

II. Literature Review

a) Quality management

It is the act of overseeing all activities and tasks needed to maintain a desired level of excellence. Quality management includes the determination of a quality policy, creating and implementing quality planning and assurance, and quality control and quality improvement. Quality management ensures that an organization, product or service is consistent. It has four main components: quality planning, quality assurance, quality control and quality improvement. Quality management is focused not only on product, and service but also on the means to achieve it.

b) Lean

Lean is a systematic approach to identifying and eliminating waste through continuous improvement of the product at the demand of the customer. Taiichi Ohno once said that "Lean Manufacturing is all about

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looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non – value added wastes" (Ohno, 1988). Poor layout (distance), long setup times, incapable processes, poor maintenance practices, poor work methods, lack of training, large batches, ineffective production planning/scheduling, lack of workplace organization generate wastes. By eliminating wastes in the overall process, through continuous improvements, the product's lead time can be reduced remarkably. By reducing lead time organization can obtain operational benefits (enhancement of productivity, reduction in work-in-process inventory, improvement in quality, reduction of space utilization and better organization) as well as administrative benefits.

c) *Lean Approach*

Lean organizations are highly customer focused, providing the highest quality, lowest cost products in the shortest lead time possible. According to the book "Lean Thinking" by James P. Womack and Daniel Jones, the Lean approach summarizes five principles (Womack and Jones, 2003):

Specify what creates value from the customer's perspective - Value should be specified from the customer point of view, not by the perspective of individual firms, functions, and departments. If the customer does not pay for an activity, it is a non-value adding activity and it should eliminate.

Identify all the steps along the process chain – This means identifying the value stream. It can be used to identify activities where the value adds to the product and those do not.

Make those processes flow – The value-added product must flow continuously from start to finish without interruptions, detours, backflows, waiting, scrap and stoppages.

Make what is pulled by the customer – The customer should pull the product from the source as needed rather than process pushing the products onto the customer.

Strive for perfection – After implementing the above steps, the team should continuously remove wastes as they are in uncover condition and pursue perfection through continuous improvement. Lean uses practically proven tools and techniques to systematically eliminate the wastes. If these are correctly applied, it will bring improvements to quality, cost, and delivery of the final product. Those tools help in implementing, monitoring, and evaluating Lean efforts and their results. Without proper understanding of lean approaches, it can spoil Lean efforts in one's organization garment, component or style.

d) *Toyota Production System*

It is a manufacturing system developed by Toyota in Japan after World War II, which aims to increase production efficiency by the elimination of waste. The Toyota production system was invented and made to work, by Taiichi Ohno. While analyzing the problems inside the manufacturing environment; Ohno came to conclude that different kinds of wastes (nonvalue added works) are the main cause of inefficiency and low productivity. Ohno identified waste in several forms, including overproduction, waiting time, transportation problems, inefficient processing, inventory, and defective products.

Pareto Diagram: The Pareto diagram is a graphical overview of the process problems, in ranking order from the most frequent, down to the least frequent, in descending order from left to right. Thus, the Pareto diagram illustrates the frequency of fault types. Using a Pareto, one can decide which fault is the most serious or most frequent offender.

Fishbone Diagram: A framework used to identify potential root causes leading to poor quality.

Histogram: A graph of variable data providing a view of the distribution of data around the desired target value.

Scatter Diagram: A graph used to display the effect of changes in one input variable on the output of an operation.

e) *Just in Time*

Just-in-time manufacturing is a Japanese management philosophy applied in manufacturing. It involves having the right items with the right quality and quantity in the right place at the right time. In general, Just in Time (JIT) helps to optimize company resources like capital, equipment, and labor. The goal of JIT is the total elimination of waste in the manufacturing process. Although the JIT system is applied mostly to the manufacturing environment, the concepts are not limited to this area of business only. The philosophy of JIT is a continuous improvement that emphasizes on prevention rather than correction and demands a companywide focus on quality.

III. Method and Materials

The methodology adopted for this study is a case study and brain storming. The case study conducted on a garment factory named Ananta Apparels Ltd. Located at Narayanganj. At first preliminary investigation was carried out at cutting, sewing, washing, finishing and packing section to identify the area where most of the defects occur. It finds that, the sewing section is highly suffered from defect and rework problems. For this reason, the sewing line is identified to conduct research work. The work

aims to minimize the defect percentage by using the DMAIC approach of Six Sigma methodology. Secondary data of the sewing section collected from the management of the factory. The data collected for polo shirts only. According to our observation and using the end line quality data provided by the management, then 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 perform. 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 in 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.

a) Data Collection

Data sheets collected for garment item such as polo shirt for three months. The data collected by the end line quality inspectors from two production lines of sewing section. We checked 3500 polo shirts, and 470 pieces were found defective.

b) 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, the goal of the project and the process that needs to be improved to get a 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 the defect to the 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: Shows the SIPOC Flow of Ananta Apparels Ltd

Suppliers	Inputs	Processes	Outputs	Customers
-Acotex Bangladesh Ltd. -Fabian Group - D.H Fashion	Unstitched cloth Machinery Thread Needles Button Zipper Label	Cutting Sewing Washing Ironing Finishing Packaging	T-shirt Polo shirt Pant	-H&M -Tesco -ZARA

Measure Phase: At this phase, the percentage of defects, existing DPMO (Defect per Million Opportunities) and calculation of the Sigma Level of the selected factory indicated in table 2.

Now, Table-2 shows the DPMO and Sigma level of Existing process-

Table 2: DPMO and Sigma level of Existing process

Total Checked pieces	**3500**
No. of Defectives	470
% Defectives	13.42
DPO	0.1342
DPMO	134285
Sigma level	2.6063

Calculation of the Sigma level by using the following formula in Ms. Excel:

Sigma Level- Normisnv (1-Defects/Total opportunities) +1.5; Where, Defects- 470, Total Opportunities - 3500, Sigma shift= 1.5.

In the following table the Frequency of Defects of the Inspected polo shirts are given:

Table 3: Frequency of Defects of the Inspected Polo Shirts

Defects	Real Occurrence	Percentage (%) of Occurrence
Skip Stitch	45	9.57
Down Stitch	37	7.87
Broken Stitch	134	28.51
Raw Edge	42	8.94
Joint Stitch	35	7.45
Uneven Stitch	38	8.09
Spot/Oil stain	25	5.32
Hole/Damage	15	3.19
Puckering	39	8.30
Reject	7	1.49
Slanted	5	1.06
Uncut Thread	2	0.43
Reverse	19	4.04
Size Mistake	4	0.85
Process Missing	23	4.89
Total	470	100.00

Analyze phase: Two problem solving six sigma tools used at analyzing phase and these were: Brainstorming and cause and effect diagram.

Brainstorming: Brainstorming is one of an essential problem-solving tools. The goal of this tool is to identify the issues, solutions and opportunities. To find out the potential causes of the defects and their respective solutions, we arranged a brainstorming session where they applied the Round Robin method with the presence of the following members that are shown in table 4.

Table 4: Attendants at the Brainstorming Session

Attendants	Numbers
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, engineers, and floor manager, we recognized various probable causes. Then we identified the potential causes by online inspections and root cause analysis.

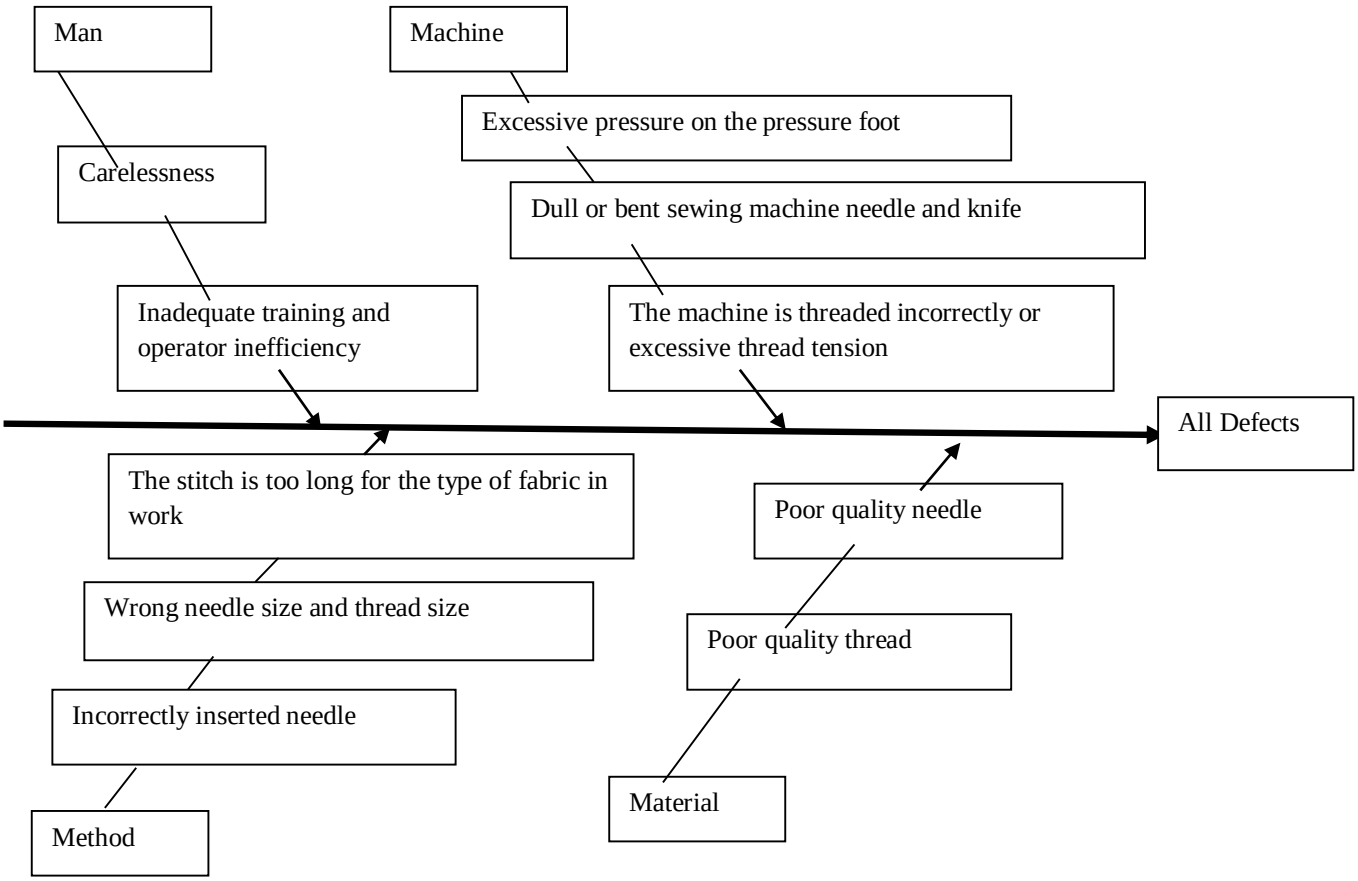

Figure 2: Cause & Effect Diagram for All Major Defects

Improve Phase: The purpose of the DMAIC Improve phase is to discover a solution to the problem that the task aims to address. This improve phase involves brainstorming potential solutions, selection of solutions to test and evaluating the results of the implemented solutions. Often a pilot implementation is conducted before 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. Table-5 gives necessary solutions with their corresponding causes.

Table 5: Suggested solutions against causes of defects

Areas	Causes	Suggested Solutions
Man	Inadequate training and operator inefficiency	Trained and motivated operators sufficiently
	Negligence	Improved supervision.
Machine	The machine is threaded incorrectly or excessive thread tension	Rethread machine and maintain proper thread tensions.
	Excessive pressure on the presser foot.	Minimize the pressure on the presser foot.
	Bent sewing machine needle and knife.	Replace the needle and knife with a new one.
Method	Incorrect size of the needle and thread for operation	Ensure that the correct thread type and size rightly feeds both the needle and bottom (looper) positions.
	Comparatively long stitch for the type of fabric in work.	Shorten the stitch length using the stitch regulator, especially when sewing fine fabrics

Material	Incorrectly inserted needle	Check that the bobbin wounds correctly and no loose threads or loops sticking out.
	Poor quality thread	Using core spun yarn
	Poor quality needle	The needle should have high heat resistance capacity.

c) Implementation of the Solutions

Based on the solutions provided by this study, we took some corrective actions mentioned in table-6. We implemented it into one of their pilot sewing line. The pilot line had a total of 105 sewing machines.

Table 6: Corrective Actions and Its Amount

Corrective Actions	Amount
Replacement of dull or bent sewing machine needles	16 needles
Replacement of dull knives	9 knives
Number of machines rethreaded	17 machines
Correction of needle insertions	15 machines
Replacement of faulty bobbins	3 machines
Training provided	machines 2 hours each day

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

Control Plan: The management needs to take the initiative on the following obligatory activities to withstand the progress after Six Sigma implementation:

i. Arrange training continuously for the garments operators on the issue of quality.
ii. Always use quality threads, needles, and other garment accessories.
iii. A sound incentive scheme should take for high-quality performance.
iv. Preventing defects will be given more priority than correcting defects.
v. Enforce strict quality control in the line.
vi. The organization should develop a proper Quality Management System.

IV. Results and Discussions

We implemented all the suggested solutions into one of their pilot sewing lines. After the implementation of solutions percentage of defectives, then we calculated DPMO and Sigma Level by using the previous sigma level formula and reported on table 7.

Table 7: DPMO and Sigma Level after Improvement

Total Checked	**5450**
No. of Defectives	396
% Defectives	7.26
DPO	0.072
DPMO	72660
Sigma level	2.9562

V. 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 to find out the major defects, their root causes and then suggests logical solutions to minimize those defects. This study identified some defects (broken stitch, skip stitch, raw edge, uneven

stitch, down stitch, process missing, puckering and joint stitch) those were responsible for more than 80% of total defects occurring in the sewing section of the garment factory for the item of a polo shirt. After finding the major defects, brainstorming tool was used to identify the probable causes and then we identified potential root causes by online inspections and root cause analysis. A significant improvement of the Sigma level found in the industry. So this method is very operative to the minimization of defects. If many garment factories in Bangladesh follow the six sigma concept, then they can minimize most of the defects in the sewing section.

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