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Reduction in defects rate using DMAIC approach-A Case Study

Jitender Kumar[1], Mukesh Verma[2], K.S. Dhillon[3]
[1]M.Tech Scholar, SSIET, Dera Bassi
[2,3]Associate Prof., ME Deptt. SSIET, Dera Bassi

Abstract: The paper is related to the thread manufacturing process. This work clearly identified the different problems occurring during manufacturing. In the last process (winding), DMAIC tool is applied. The reason for choosing this work is to provide a better analysis of different processes in thread manufacturing. This textile firm has large departments where the thread produced from the waste clothes, after passing through different processes. Thousands of defects opportunities create in the final package of thread. That's why it is decided to do work and implement DMAIC methodology in winding departments where the final package of thread is to be made. Final package of thread is the end product and it is directly sent to the customers, any defect may lead to the customer's complaints. With the help of DMAIC approach the defects has been reduced from 13012 to 513 and the sigma level of the industry has been increased from 3.8 to 5.03.

Keywords: DMAIC, Process Capability, Six Sigma.

INTRODUCTION

The DMAIC is a financial improvement strategy for an organization and now days it is being used in many industries. Basically it is a quality improving process of final product by reducing the defects; minimize the variation and improve capability in the manufacturing process. The objective of DMAIC is to increase the profit margin, improve financial condition through minimizing the defects rate of product. It increases the customer satisfaction, retention and produces the best class product from the best process performance.

LITERATURE REVIEW

Motorola was the first organization to use the term DMAIC in the 1980s as part of its quality performance measurement and improvement program. Recent DMAIC success stories, primarily from the likes of General Electric, Sony, Allied Signal, and Motorola, have propagated the use of quality tools for gaining the knowledge. Some of the pioneering companies, which use DMAIC methodology, are ABB, General Electric (GE), Allied Signal and Texas Instruments. General Electric spent 500 million dollars on DMAIC works in 1995 and gained more than 2 billion dollars from that investment. In 2001 Horel shows that the Six Sigma improvement methodology has received considerable attention recently, not only in the statistical and quality literature, but also within general business literature. Ponce in 2004 shows that six sigma knowledge characteristics, and their impact on performance and gains, have not yet been addressed regardless of its knowledge content. In 2005 Kundi studied the implementation of Six Sigma in the UK organizations. Six sigma is an effective way to find out where are the greatest process needs and which are the softest points of the process. Also, Six sigma provide measurable indicators and adequate data for analytical analysis. Systematic application of Six Sigma DMAIC tools and methodology within an automotive parts production results with several achievements. Reduced tool expenses for 40 %, Reduced costs of poor quality (CORQ) for 55 %, and reduced labours expenses for 59 %. Production time reduction for 38 %, and Index cost/volume reduction for 31 %. Generally, improvements through reduced Production time, Control time, Material and Internal scrap will give annual benefits of $ 72 000(Sokovic, 2006). In 2009 Naidu implemented DMAIC in garment industry. The focus was exporting the final product to European countries. It was operating at a percentage defective of 4.42. After implementing the DMAIC methodology the percentage defective is reduced to 1.95. Ray in 2011 shown that Savings of Rs.1.070 Lakh per annum. Reduction in follow-up time for resolving the complaints from 2 Man-days / week to 1 man-day / week. Average time taken for closure reduced from 42 days to 21 days. Ratio of pending complaints reduced from 1.25 to 0.97. In 2012 Ganguly analyzed that the cycle time was reduced from 47 days to 20 days, resulting in a huge inventory reduction and better order compliance. Dambhare (2013) analyzed the major problem of continuous rework up to 16%, which was leading to wastage of man hours and labor cost. The

DMAIC methodology was successfully implemented to reduce the rework from 16% bores per month to 2.20% bores per month. The other problem of non uniform step bores was also reduced significantly.

PROBLEM FORMULATION

In all processes the smallest variation in quality of raw material, production conditions, operator behavior and other factors can result in a cumulative variation (defects) in the quality of the finished product. DMAIC approach aims to eliminate these variations and to establish practices resulting in a consistently high quality product. Therefore, a crucial part of DMAIC work is to define and measure variation with the intent of discovering its causes and to develop efficient operational means to control and reduce the variation. The expected outcomes of DMAIC efforts are faster and more robust product development, more efficient and capable manufacturing processes, and more confident overall business performance.

METHODOLOGY- DMAIC APPROACH

D- DEFINE PHASE: The definition of the problem is the first and the most important step of any DMAIC project because a good understanding of the problem makes the job much easier. In this phase, the purposes of work, scope and process background for both internal and external customers are defined. The present work deals with the reduction of rejection in the textile industry. The product of this industry is thread from the waste cloth pieces and having high rate of rejection due to defects in various operations. The thread produced in this industry after passing waste cloth pieces through the various departments such as blow room, carding section, draw frame section, combing section and winding section. All the departments of the industry are chosen for the complete analysis.

M- MEASURE PHASE

The measure phase identifies the defects in the product, gathers valid baseline information about the process and establishes the improvement goals. Defects in the different sections has been identified.

Defects in Blow Room

- Neps formation
- Curly cotton due to tight gauge
- Lap licking

Defects in Carding Section

- Neps formation
- Holes or patches in card web
- High sliver variation

Defects in Draw Frame Section

- Variation in Draw Frame Sliver

Defects in Combing Section

- Lap weight variation
- Number of piecing in comber
- Brush cleaning problem

Defects in Winding Section

- Breakage of yarn during winding

Measure the performance of the process by collecting the data and also write down the importance of different critical defects regarding to customer value.

Data Collection : The data is collected to find the current rate of rejection and sigma level of all departments to measure that which one is most critical.

TABLE 1.1: Rate of Rejection of Departments

DEPARTMENT	DEFECTS	PRODUCTION	DEFECT%	DPMO	SIGMA LEVEL
BLOW ROOM	1035	1227130	0.08	843	4.64
CARDING	370	1227130	0.03	302	4.93
DRAW FRAME	1220	1227130	0.1	994	4.59
WINDING	13012	1227130	1.06	10604	3.80
PACKING	393	1227130	0.32	320	4.91

Table 1.1 shows that defect percentage is highest and the sigma level is low in the winding department. So, winding defects are most critical defects which are to be removed or reduce at the most.

TABLE 1.2 Defect Percentages and Sigma Level

Departments	Blow Room	Carding	Draw Frame	Winding	Packing
Defect %	0.11	0.03	0.1	1.06	0.32
Sigma Level	4.64	4.93	4.59	3.8	4.91

Chart between Defect Percentage and Sigma Level

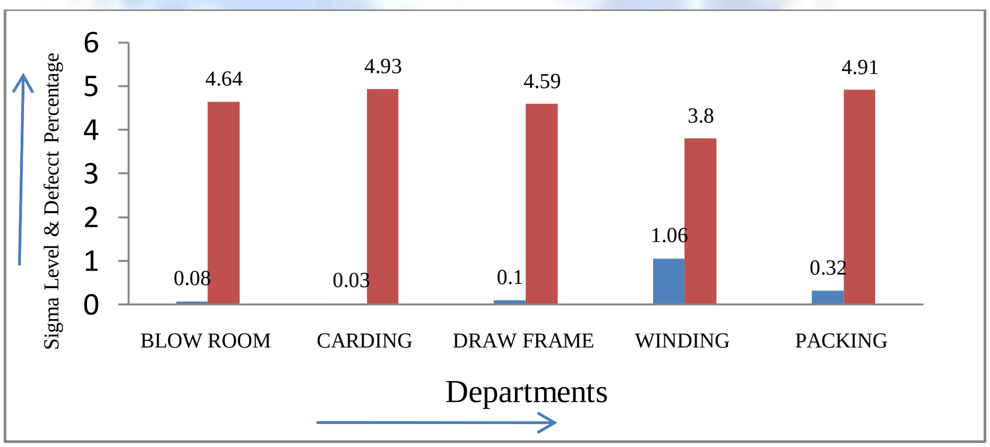

Fig. 1.1 Chart between Defect Percentages and Sigma Level

A- ANALYZE PHASE: During production of yarn failures occur at many stages. All such failures are recorded in the manufacturing plant. It was observed that worst defects percentage is at winding stage. So it is useful to implement DMAIC tool in this process to eliminate large variation. Winding section is very critical department in yarn manufacturing process. In this department there are comparatively more chances of defects opportunities in the final yarn. It is the last section of manufacturing process where defects can be minimized or eliminated.

Data is collected from internal and External Customers for inspection, overhauling, scan cuts, guide, gas kit, disk, temperature, humidity, count, machine change, speed, and yarn type.

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Cause and Effect Analysis

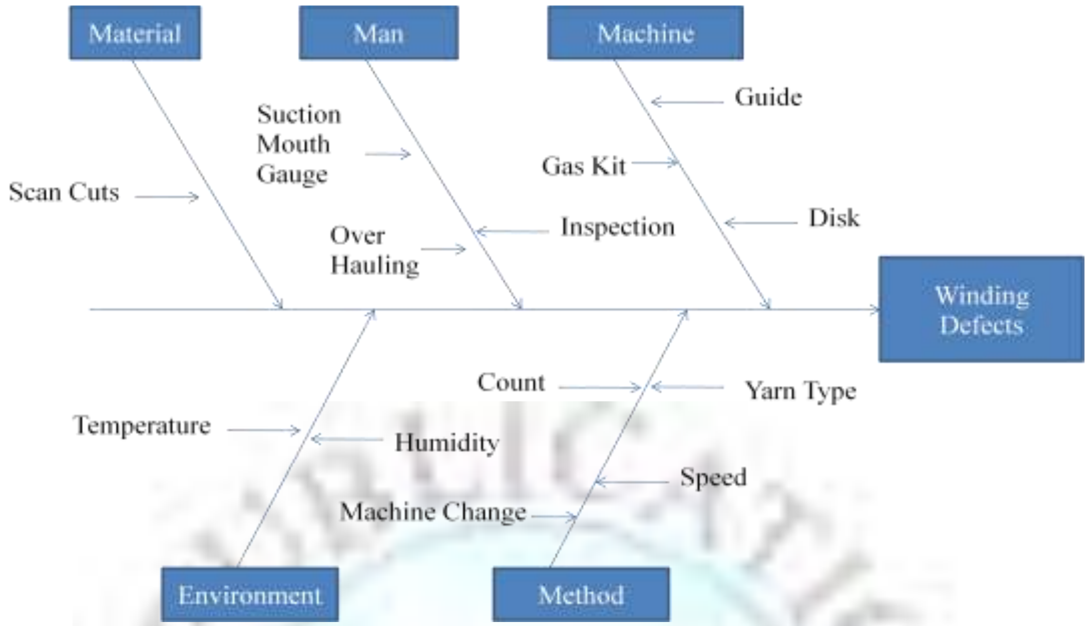

Fig 1.2: Cause and Effects Diagram

TABLE 1.3 : Customer Voice

	RATING OF IMPORTANCE OF CUSTOMER		**10**	**6**	**6**	**1**	**8**	**8**	**9**	**7**	
	KEY PROCESS OUTPUTS		**DEFECT RATE**	**REWORK**	**B-GRADE YARN**	**HARD WASTE**	**CUSTOMER COMPLAINT**	**CUSTOMER RETURN**	**CUSTOMER CLAIMS**	**INSPECTION**	**FAILURE**
S.N.	PROCESS STEP	PROCESS INPUT									TOTAL
1	MAN	INSPECTION	3	3	3	3	1	1	1	1	101
		SUCTION MOUTH GAUGE	9	9	1	9	9	6	6	1	340
		OVER HAULING	3	3	3	6	1	1	1	3	118
2	MATERIALS	SCAN CUTS	9	9	9	9	9	9	3	6	420
3	M ACHINE	GUIDE	9	9	1	3	3	3	3	1	207
		GAS KIT	9	9	1	1	1	3	3	1	217
		DISK	3	3	1	3	3	1	1	1	105
4	ENVIRONMENT	TEMPERATURE	3	3	3	6	3	3	3	3	168
		HUMIDITY	3	3	3	3	1	1	1	1	101
5	METHODS	COUNT	6	6	6	6	1	1	1	3	184
		SPEED	9	9	6	9	9	6	6	6	405
		YARN TYPE	3	3	3	3	1	1	1	1	101
		MACHINE CHANGE	3	3	1	3	3	1	1	1	105
		TOTAL	**930**	**558**	**240**	**68**	**496**	**400**	**396**	**210**	

Causes of Winding Defects : From Table 1.3, some significant factors are found which causes major effects on the defects on the product in the winding process.

- Scan cuts
- Speed of winding machine
- Suction mouth gauge

Above parameters initially found are shown in the Table 1.4

TABLE 1.4: Parameters initially used

PARAMETERS	SCAN CUTS	SPEED	GAUGE
Initial Value	45	1500 rpm	8 mm
RANGE	37- 45	700-1500 rpm	5-8 mm

I- IMPROVE PHASE

In order to improve the process, some preventive action should be taken and critical parameters found are to be changed.

TABLE 1.5 Changed Settings of Parameters Used and its effect

SCAN CUTS	SPEED	GAUGE	DEFECTS	PRODUCTION	DEFECT%	DPMO	SIGMA LEVEL
45	1500 rpm	8 mm	13012	1227130	1.06	10604	3.8
43	1400 rpm	8 mm	10657	1134275	0.94	9395	3.85
42	1300 rpm	7 mm	8652	1082813	0.8	7990	3.91
40	1200 rpm	7 mm	2866	989524	0.29	2896	4.26
37	700 rpm	6 mm	643	659372	0.1	975	4.6
37	1000 rpm	6 mm	629	818259	0.08	769	4.67
37	1200 rpm	<6 mm	513	1056981	0.05	205	5.03

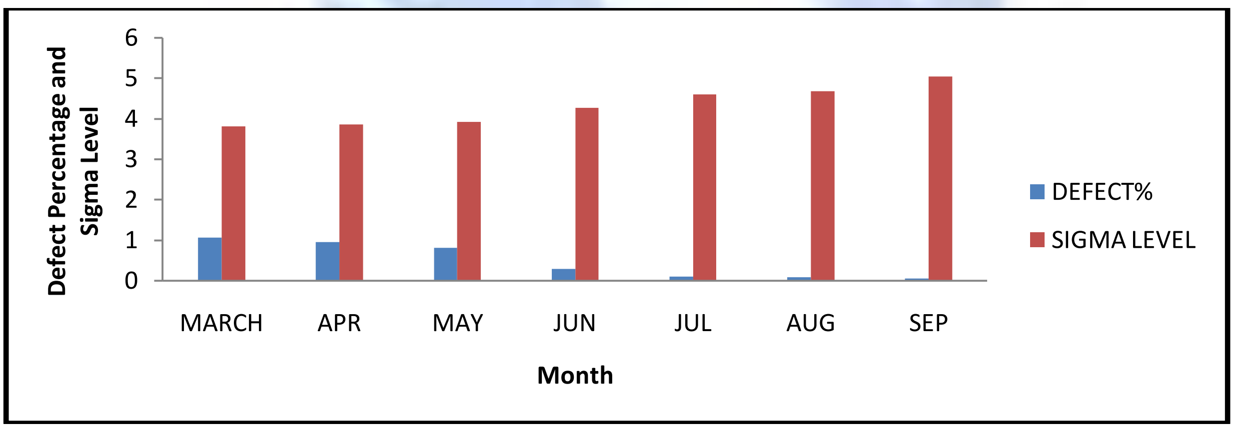

Fig. 1.3: Chart between defect % and Sigma Level

C- CONTROL PHASE

The final stage of Six- Sigma implementation is to hold the gains that have been obtained from the improve stage. Unless there is a good control, we are likely to go back to the original stage. Hence, in this stage the new process conditions are documented, and frozen into system so that the gains are permanent. The process is assessed once more after the setting-in period in order to check whether the improvements are being sustained or not. In control phase, the process will be check by applying the control charts whether it is control or not. Variation of whole process should be in control limits for control process.

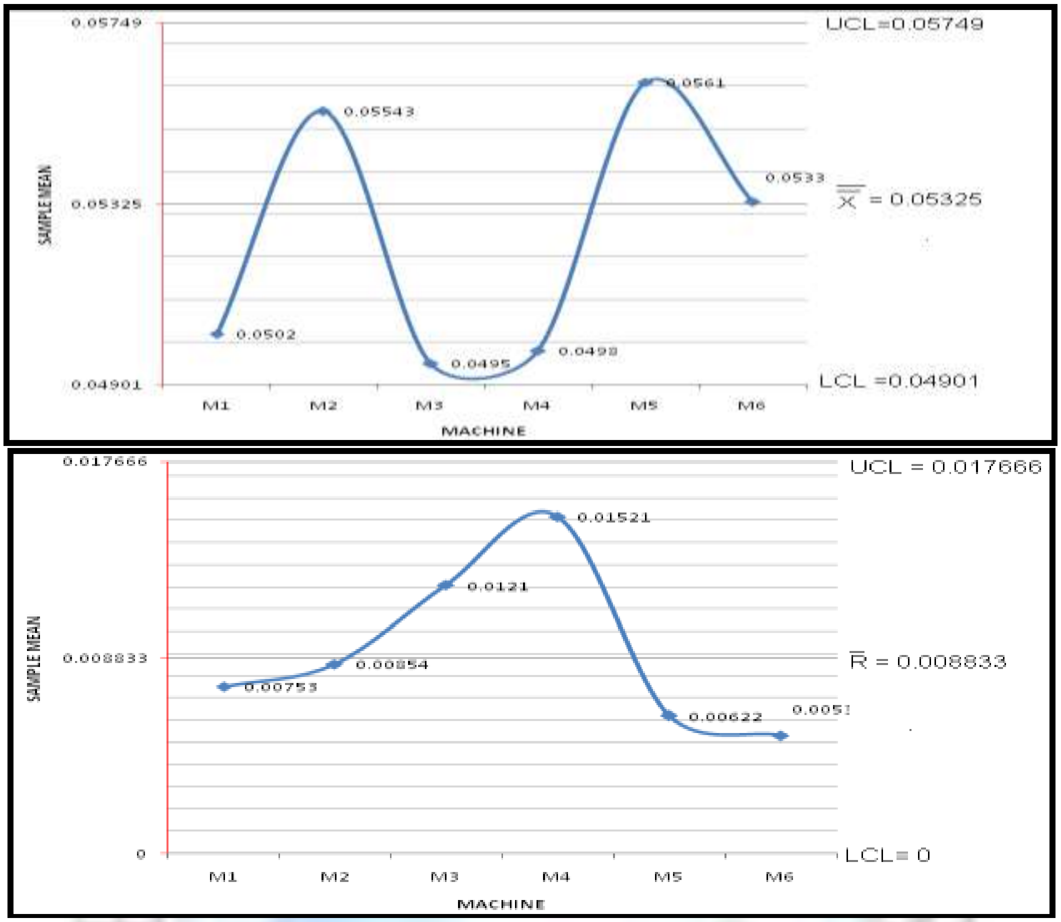

Fig 1.4: Control Chart ($\overline{X}$ *and R*)

Data of defects percentage and range shows that the process is under control and there is no point in this graph which is out of control limits.

RESULTS

With the implementation of DMAIC approach the root causes of winding defects are identified. The defects have been reduced from 13012 units per month to 513 units per month. The sigma level of the industry has been increased from 3.81 to 5.03.

CONCLUSION

It is necessary to work in a systemic way and try to improve financial condition of the organization. Winding speed should be 1200 meter per minute for getting good quality. Scan-Cuts and Disk life are most important factors. They need to be controlled to achieve optimum results best Scan-Cuts are below 40. Condition of Disk should be good always .The suction mouth gauge should be less then 6 mm.

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