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QUALITY IMPROVEMENT INJECTION PART OF SET TOP BOX (STB) USING SIX SIGMA METHOD IN ELECTRONIC COMPANY

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ABSTRACT

The company pays full attention to product quality. Electronic companies that produce set-top box (STB) products, carry out their business activities by implementing a production quality control system, but in reality, there is still poor product quality, for this reason, the research aims to reduce existing injection part production defects using the Six Sigma method. There are 5 (five) types of problems as CTQ (critical to quality) that must be improved so that the problem of injection part defects in set-top boxes (STB) can decrease by 50% or 350 ppm (4.89σ) company target. The sigma level of defective injection part products from January to December 2022 is 4.69σ. Analysis and Improvement of all factors causing the occurrence of defective injection part products. The results can reduce the number of Injection part defects from January to June 2023 to 1,078 units from the total STB production of 3,645,241 units. After the calculation, it is known that the sigma level of defect injection products after improvement is 4.93σ. The improvement sigma level has passed the sigma level target of 4.89σ set by the company. This proves that the improvement has been successful and has an impact on part defect injection

Keywords*: six sigma; DMAIC; quality improvement; defects; injection part*

ABSTRAK

Perusahaan memberikan perhatian penuh terhadap kualitas produk. Perusahaan elektronik yang memproduksi produk set-top box (STB), menjalankan kegiatan usahanya menerapkan sistem pengendalian kualitas produksi, namun kenyataannya masih ditemukan kualitas produk yang kurang baik, untuk itu penelitian bertujuan mengurangi cacat produksi injection part yang ada menggunakan metode six sigma. Ditemukan ada 5 (lima) jenis masalah sebagai CTQ (critical to quality) yang harus perbaikan agar masalah defect injection part pada set-top box (STB) dapat turun 50% atau 350 ppm (4,89σ) target perusahaan. Tingkat sigma produk defect injection part dari bulan Januari hingga Desember 2022 adalah 4,69σ. Analisis dan Perbaikan terhadap seluruh faktor penyebab terjadinya produk defect injection part. Hasilnya dapat membuat jumlah defect Injection part dari bulan Januari sampai dengan Juni 2023 berkurang menjadi 1.078 unit dari total produksi STB sebesar 3.645.241 unit. Setelah dilakukan perhitungan diketahui bahwa level sigma produk defect injection setelah dilakukan perbaikan adalah 4.93σ. Level sigma improvement tersebut telah melewati target level sigma 4.89σ yang telah ditetapkan oleh perusahaan. Hal ini membuktikan bahwa improvement telah berhasil dan membawa dampak pada part defect injection.

Kata Kunci*: enam sigma; DMAIC; peningkatan kualitas; cacat; bagian injeksi*

INTRODUCTION

Technological developments, especially in the electronics industry, are increasing during unstable world economic conditions and fluctuating conditions due to the pandemic. This is a challenge that must be faced by electronic industry players in the country, especially producers. These

conditions make the company must give full attention to the quality of the products produced, to gain consumer confidence for the resulting product and to be accepted by consumers so that it outperforms its competitors' products. Products that have high quality cause companies to reduce error rates, reduce rework and waste, reduce insurance costs, reduce customer dissatisfaction, reduce inspection and testing, reduce product delivery time to market, increase yield increase the utilization of production capacity, and improve the performance of product or service delivery (Nasution, 2005).

Product quality control is a control system that is carried out from the early stages of a process to the finished product, and even to the distribution to consumers (Susetyo, 2011). Many methods explain quality with quality control to answer all problems in the industry. One of the methods used in quality control is six sigma. Six sigma is a method designed to improve processes focused on reducing process variations while reducing defects to zero defects (products/services that are outside the specifications) by using statistics and problem-solving tools intensively (Manggala, 2005).

Electronic companies that produce Set-Top Box (STB) products, in carrying out their business activities always implement a production quality control system, but in reality, there is still a poor quality of products. This is due to the lack of maintaining the quality of products that come from suppliers or vendors during the production process. Set-Top Box is a product consisting of a combination of two parts namely: the Injection Part and the Press Part.

Many ways to define quality. Most people have a conceptual understanding of quality. This relates to one or more of the desired characteristics in either the product or service that must be owned. Although this conceptual understanding can, however, be a useful starting point in choosing a good definition, it is precise and useful. The definition of quality (Heizer & Render, 2005), states that the meaning of quality or quality is the overall pattern and characteristics of a product or service that is capable of meeting the needs of the obvious and hidden. Understanding quality according to some experts who are widely known (K. S. Krishnamoorthi, 2011), among others: "Juran, quality is fitness for the use which when translated freely means the quality (product) related to the taste of the goods used.

The controls are important. Control can mean an evaluation to indicate needed corrective responses, the guiding act, or the state of the process in which the variability is attributed to a constant system of chance causes (Gasperz, 2001). Control can be interpreted as activities carried out to monitor the activity and ensure the actual performance performed is following the plan. Quality control is an effort to maintain the quality or quality of the goods produced, to comply with the product specifications that have been determined at the discretion of the company's leadership (Assauri, 1998).

This research aims to determine the problem as CTQ (critical to quality) which must be repaired so that the problem of injection part defects in set-top boxes (STB) can be reduced and the factors causing product defects and repair solutions can be identified.

RESEARCH METHODOLOGY

Sigma (σ) is a Greek letter in Statistics as standard deviation describes how much a value shifts from the target value of a population. This is what is referred to as a measure of variation/deviation (Management Innovation PT. Samsung Electronics Indonesia, 2007). Six Sigma is a statistical concept that measures a process related to defects at the level of Six Sigma there are only 3.4 defects out of a million opportunities (Brue, 2002). Six Sigma is a management philosophy that focuses on removing defects by emphasizing the understanding, measurement, and improvement of processes through the DMAIC (Define, Measure, Analyze, Improve, and Control phases).

1. Define the Problem

Define is the first step in the DMAIC methodology, this step is the initial operational step in the Six Sigma quality improvement program. At the defined stage 2 things need to be done, namely:

a. Defining the core processes of the company

The core process is a chain of tasks, usually covering various departments or functions that transmit value (products, services, support, and information) to external customers. If the selection of a Six Sigma theme is first done is to consider and explain the purpose of a core process will be evaluated (Pande, 2002).

b. Defining customer needs specific needs

The next step is to identify the most important players in all processes, namely customers, customers can be internal and external is the task to determine well what external customers want. This job makes the voice of the customer (VOC) voice of customer voice challenging.

In terms of defining the specific needs of customers is important to understand and distinguish between two categories of critical requirements, namely output requirements and service requirements.

2. Measure

This stage is the stage to validate the problem and measure/analyze the problem from the existing data. At this stage, data collection is carried out that supports the process that is the focus of the problem.

3. Analyze

The third stage in DMAIC is Analyze, where at this stage, a cause-and-effect relationship analysis of various factors is studied to determine the dominant factors that need to be controlled.

4. Improve

At this stage, a solution is designed to control and improve the quality with Six Sigma at the most critical service in the form of a proposed quality improvement for each potential CTQ so that it is expected to improve the performance of the quality of the service with the increasing value of DPMO and sigma capability level.

5. Control

At this stage, a control sheet will be created that is used to control the process or service at the time of implementation so that it can achieve the Six Sigma target. The essence of the Six Sigma concept is to lower the defect by reducing the variation the lower the variation of a process, the smaller the defect and the higher the Sigma level.

Table 1. Sigma level conversion [10]

Nilai Sigma(σ)	**DPMO (*Defect Per Million Opportunities*)**	***Yield* (%)**
1	690.000	30,9
2	308.000	69,2
3	66.800	93,3
4	6.210	99,4
5	320	99,98
6	3,4	99,9997

RESULTS AND DISCUSSIONS

The problem of injection part quality from the production of Set-Top Box (STB) was obtained based on research on electronic manufacturing companies. The results of the study can be obtained after going through the stages in the Six Sigma DMAIC (Define, Measure, Analysis, Improvement, Control) method.

1. Define

At this stage identifying a problem or project selection is important to produce maximum results. In this study, the total product defect injection part from set-top box (STB) production is one

of the main factors for the company to measure the performance of the production process. Whether the production process can already produce products with the quality that the company expects.

Total production of Set-Top Box (STB) from January to December 2020 amounted to 10,414,884 units, there are total defect injection part products of 7,291 units. The problem of defect products injection part reached 7,291 units consisting of scratch problems which ranked first at 2295 (31%), second printing NG of 1383 (19%), third vinyl NG of 1210 (17%), fourth short mold of 1318 (18%) and the fifth knob bending of 1085 (15%). This causes researchers to designate 5 (five) types of problems as CTQ (critical to quality) that must be improved so that defect injection part problems in set-top boxes (STB) can drop 50% or 350 ppm according to the company's target.

Table 2. Production of injection part STB (Jan – Dec 2022)

No.	Month	Production	Defect	DPMO (ppm)
1	January	643.163	362	563
2	February	906.453	1091	1204
3	March	754.786	705	934
4	April	805.445	616	765
5	May	860.491	885	1028
6	June	1.263.097	921	729
7	July	973.416	557	572
8	August	811.423	573	706
9	September	885.454	716	809
10	October	1.058.499	383	362
11	November	791.656	192	243
12	December	661.001	290	439
Total		**10.414.884**	**7.291**	**700**

2. Measure

The measure is the assessment stage of the measurement system and assesses the performance baseline capability (output) of the company.

Table 3. The *P* control

No.	Month	Defect Product	*p*	CL	LCL	UCL
1	January	362	0.000563	0.0007	0.000601	0.000799
2	February	1091	0.001204	0.0007	0.000617	0.000783
3	March	705	0.000934	0.0007	0.000609	0.000791
4	April	616	0.000765	0.0007	0.000612	0.000788
5	May	885	0.001028	0.0007	0.000615	0.000786
6	June	921	0.000729	0.0007	0.000629	0.000771
7	July	557	0.000572	0.0007	0.000620	0.000780
8	August	573	0.000706	0.0007	0.000612	0.000788
9	September	716	0.000809	0.0007	0.000616	0.000784
10	October	383	0.000362	0.0007	0.000623	0.000777
11	November	192	0.000243	0.0007	0.000611	0.000789
12	December	290	0.000439	0.0007	0.000602	0.000798

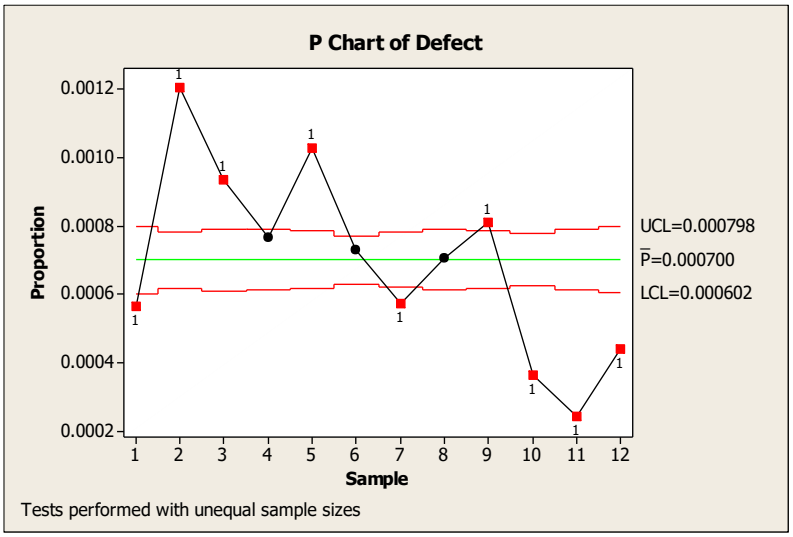

Figure 1. *P*-control chart

The p-control chart (before improvement) shows that from the data obtained only 3 points of proportion are between the upper control limit (UCL) and the lower control limit (LCL) which means that it is controlled while 9 points of proportion out of the upper control limit (UCL) and the lower control limit (LCL) so it can be said that the process is out of control and indicates a high deviation. It states that quality control at electronic manufacturing companies requires improvement. DPMO (Defect per Million Opportunities) and Sigma-level measurements are performed to determine the current performance condition of the process. In February the problem of defective product Injection part in the Set-Top Box (STB) experienced the highest point of 1204 ppm while in November was the lowest point of 243 ppm. The total yield (RTY) calculation is:

$$\text{DPU} = \frac{7291}{10414884} \quad (1)$$

$$= 0.0007$$

$$RTY = e^{-0,0007} \quad (2)$$

$$RTY = 0.9993$$

ZLT result after using Minitab = 3.194

Capability process (ZST) = 3.194 + 1.5 = 4.69 σ

The Sigma level of defect injection part products before the repair is 4.69σ.

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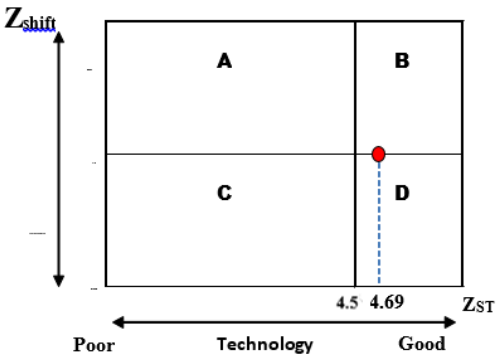

Figure 2. Block Sigma level Diagram (before the repair)

3. Analyze

Testing all factors causing the occurrence of defective products Injection parts. One of the findings uses a Cause and Effect Diagram and FDM (Function Deployment Matrix) as well as hypothesis testing.

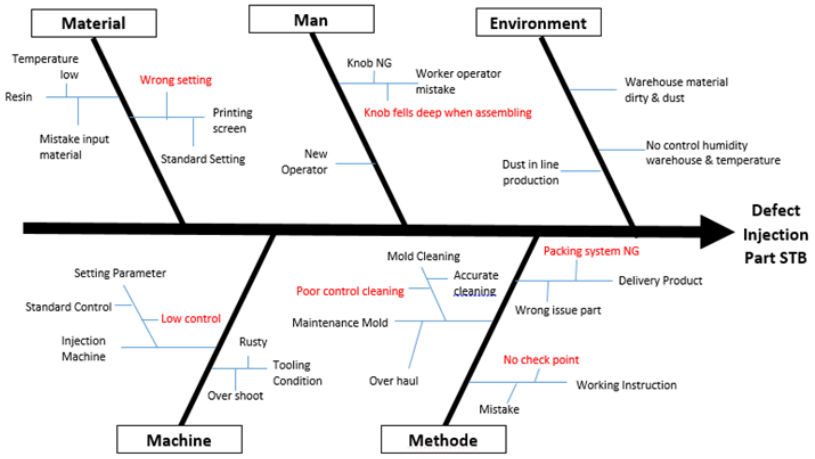

Figure 3. Diagram Fishbone

		1	2 3 4 5		
	Project Y (KPOV)	Defect injection			
	Weight	10			
	Project X (KPIV)			**Rank**	
1	*Poor Control Mold Cleaning*	10		100	14.9%
2	*Wrong Setting Screen Printing*	10		100	14.9%
3	*Low control of parameter machine settings*	8		80	11.9%
4	*No Check Point*	8		80	11.9%
5	*knob feels deep when assembling*	6		60	9.0%
6	*Packing System Injection Part NG*	6		60	9.0%
7	*Mistake input material resin*	5		50	7.5%
8	*Over shoot mold*	5		50	7.5%
9	*Working instruction mistake*	3		30	4.5%
10	*Resin Temperature Low*	3		30	4.5%
11	*Wrong Issue Part*	3		30	4.5%
	TOTAL	67		670	

Figure 4. Function Deployment Matrix (FDM

The result is as follows:

a. Less mold cleaning control causes defect injection part of products and X01 is Vital Few.
b. Errors in regulating screen printing can cause defect injection part and X02 is Vital Few.
c. Low control of machine parameter settings, can cause defect products injection part and X03 is Vital Few.
d. The absence of special instructions can cause defect injection part and X04 is Vital Few.
e. Knop feels deep when assembly, can cause defect products injection part and X05 is Vital Few.
f. Injection part packing system is not good, can cause defect products injection part and X06 is Vital Few.

4. Improve

a. X01 is a mold cleaning control that causes fewer defective product injection parts. This happens because there is no one in charge of supervising mold when producing. Then improved with the addition of standard specification preventive maintenance (PM) mold so that there are officers who supervise mold when producing.
b. X02 is incorrectly set screen printing This happens because the operator does not know how to set the screen printing. Then improved with the addition of standard screen printing settings.
c. X03 is a low control of machine parameter settings. This happens because of the absence of standard personnel in charge to control the parameters of the machine. Then infix, the addition of checkpoint history problem on the preventive maintenance dies checklist.
d. X04 has no specific instructions. This happens because there are no specific instructions that can be a guideline for the operator. Then in the fix make the addition of quality checking on working instructions.
e. X05 is a felt knop-in when assembling. This happens because of the lack of knowledge of the operator for the process of installing knobs Then improved provide training on the knob installation operator so that his knowledge and ability to penetrate.
f. X06 is not a good injection part packing system. This happens because of the lack of attention to the condition of the injection part packing system for delivery. Then in the fix provide training on the importance of keeping 5S in the warehouse for product quality.

5. Control

The number of defect Injection parts from January to June 2021 amounted to 1078 units of total STB production of 3645241 units. The total yield (RTY) calculation is:

$$DPU = \frac{1078}{3645241}$$

$$= 0.000295$$

$$RTY = e^{-0.00030}$$

$$RTY = 0{,}99970$$

ZLT result after using Minitab = 3.43

Capability process (ZST) = 3.43 + 1.5 = 4.93 σ

The Sigma level of defect injection part products after the repair is 4.93σ.

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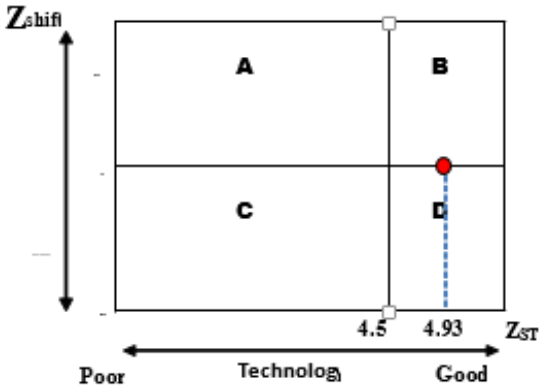

Figure 5. Block sigma level diagram (after improvement)

Sigma improvement level has passed sigma target level 4.89 σ or 350 ppm that has been set by the company, this proves that the six x-factors in improvement have been successful and bring the impact of defect injection part.

Table 5. Production of Injection Part STB (Jan – June 2023)

No.	Month	Production	Defect	DPMO (ppm)
1	January	815212	225	276
2	February	627819	187	298
3	March	597290	201	337
4	April	547421	145	265
5	May	531564	153	288
6	June	525935	167	318
Total		**3645241**	**1078**	**296**

At this stage of control, we must make a plan and measurement design so that the results that have been good from the improvement can be continuous with metrics that can be monitored and corrected to make improvements again.

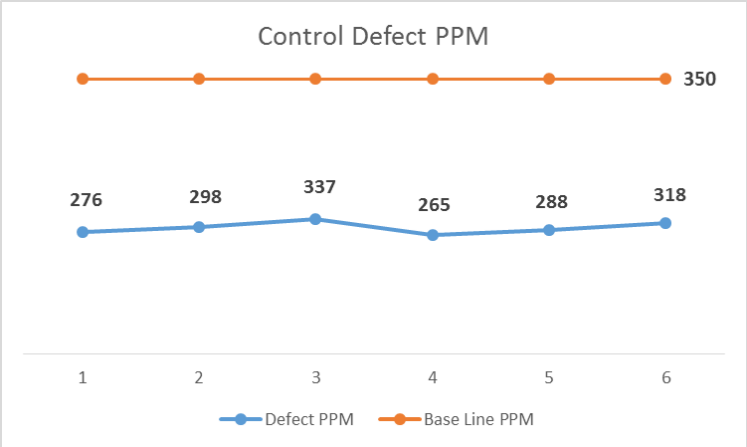

Figure 6. Chart defect graph

CONCLUSIONS

The Company can implement and implement the use of the Six Sigma method periodically so that the quality of products made or produced can be better and reduce waste. Total production of Set-Top Box (STB) from January to December 2020 amounted to 10,414,884 units, there are total defect injection part products of 7,291 units. The problem of defect products injection part reached 7,291 units consisting of scratch problems which ranked first at 2295 (31%), second printing NG of 1383 (19%), third vinyl NG of 1210 (17%), fourth short mold of 1318 (18%) and the fifth knob bending of 1085 (15%).

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One of the findings uses a Cause and Effect Diagram and FDM (Function Deployment Matrix) as well as hypothesis testing. The result of six x-factors is Vital Few, which needs improvement. The number of defective Injection parts from January to June 2021 amounted to 1078 units of total STB production of 3645241 units. After the calculation is known that the sigma level of defect injection products after the repair is 4.93σ. Sigma improvement level has passed sigma target level 4.89 σ that has been set by the company, this proves that the six x-factors in improvement have been successful and bring the impact of defect injection part.

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