Journal of Applied Research on Industrial Engineering
www.journal-aprie.com

# Improvement of Magazine Production Quality Using Six Sigma Method: Case Study of a PT.XYZ

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**PAPER INFO**

**Chronicle:**
Received: 01 October 2018
Revised: 26 December 2018
Accepted: 27 January 2019

**Keywords**:
Quality Control.
Six Sigma Pareto.
Diagrams.
Cause and Effect Diagrams.

**ABSTRACT**

Quality control is an important thing that must be done by the company to minimize defective products. The company can analyze product defects by using the Six Sigma method, by formulating Define, Measure, Analyze, Improve, and Control (DMAIC) that occurs. PT. XYZ as a large company that prints magazines often faces the problem of quality defects in its printouts, resulting in the cost losses due to production defects every year is not small, as a result of not being sold. The Six Sigma method is an approach method to help control the quality of production. This study conducts to determine the level of sigma from the current production process, the types of defects that are a priority to be addressed, and the causes of disability. From the results of the study, the sigma value of current production is 3.6 or DPMO of 15919.63613. The type of defect that occurs is blurred by 59%, does not register at 29% and paper cut by 12%. To achieve Six Sigma it is necessary to take corrective steps using the results of the analysis.

## 1. Introduction

The production process is said to be good if the process produces a product that meets established standards [1]. However, in reality the various production processes still occur [2]; deviations and obstacles that result in the product being deemed defective. This also happens to PT. XYZ. Therefore quality control is very necessary so that the company can correct the occurrence of errors or irregularities in its production [3]. After this correction, the company is expected to be able to minimize the good losses seen in terms of quantity, quality, or time. One way to improve and improve quality in a company is the Six Sigma method [4]. The Six Sigma method is a method or way to achieve operating performance in only 3.4 defects for every one million activities or opportunities [5]. Six Sigma is uniquely controlled by a strong understanding of facts, data, and statistical analysis, as well as careful attention to managing, improving, and reinvesting business [6]. Six Sigma also provides proven benefits that include cost reduction, increased productivity, growth in market share, defect reduction, and development of production or service [7]. In its application, Six Sigma has 5 (five) steps to improve business performance, namely define, measure, analyze, improve, and control so that problems or opportunities, processes, and customer requirements must be verified and updated on each step [8]. From the existence of Six Sigma, it is expected that the company can reduce the defects produced in

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DOI: 10.22105/jarie.2019.159327.1066

significant amounts so that the company is able to increase its market position in the face of competition in the food or convection business [9]. Based on the description above, this study will examine how to apply the Six Sigma method for quality control at PT. XYZ.

## 2. Literature Review

### *2.1 Definition*

Control is an activity carried out to ensure that production and operation activities are carried out in accordance with what has been planned so that if there is a deviation, the deviation can be corrected and expectations determined can be achieved [10]. Activities control is carried out by monitoring output, comparing with standards, interpreting, and taking action to readjust the processes so that they are in accordance with the standards [11]. Whereas quality is the invoices contained in an item or the results that cause the goods or results are in accordance with the purpose for what goods or results are needed [12]. So, quality control is a tool for management to maintain, improve, and maintain quality by reducing the number of damaged products so as to benefit and satisfy customer desires [13]. Six Sigma is a statistical concept that measures a process related to disability at level Six Sigma which is only 3.4 defects of a million opportunities [14]. Six Sigma is also a management philosophy that focuses on removing defects by emphasizing understanding, measurement, and process improvement [15]. In Six Sigma there is a cycle of 5 (five) DMAIC phases (Define, Measure, Analyze, Improve, and Control), namely the continuous improvement process towards the Six Sigma target. DMAIC is done systematically based on knowledge and facts. DMAIC is a closed-loop process that eliminates unproductive process steps, often focusing on new measurements and applying technology to quality improvement towards Six Sigma targets [16]. Six Sigma is a new method or technique in terms of controlling and improving products where the system is very comprehensive and flexible to achieve, maintain, support what must be done, and use which method is needed by the needs and data needed [17].

### *2.2 Stages of Quality Control Using Six Sigma Method*

In the application of quality control using the Six Sigma method, there are 5 (five) stages that must be passed, namely define, measure, analyze, improve, and control [18]. Define Phase: Determining what processes will be evaluated is determined at this stage. The process consideration that will be evaluated is the process stage that significantly affects the profit creation for the company. However, in the process, there were many product failures and defects that would affect the next process stage [19]. Measure Phase: What is done at this stage is as follows: a) determine quality characteristics: Critical to Quality (CTQ) that is directly related to the specific needs of the customer, b) plan data collection at the process level, data collected and needed is data that is used to measure baseline performance and capability process at the process level and output, c) calculate the capability of the process, which is measuring the data that is sampled according to the type of data to be converted to the sigmatic value. Analyze Phase: Things that must be considered are as follows: a) detecting the main variables that affect disability in order to help facilitate efforts to reduce the level of disability, b) quality cost conversion, c) converting the number of failures into cost of poor quality in line with the increase in sigma capabilities. Control Phase: Monitor all improvements to actions or activities to remain stable and in accordance with the specifications desired by the customer [20].

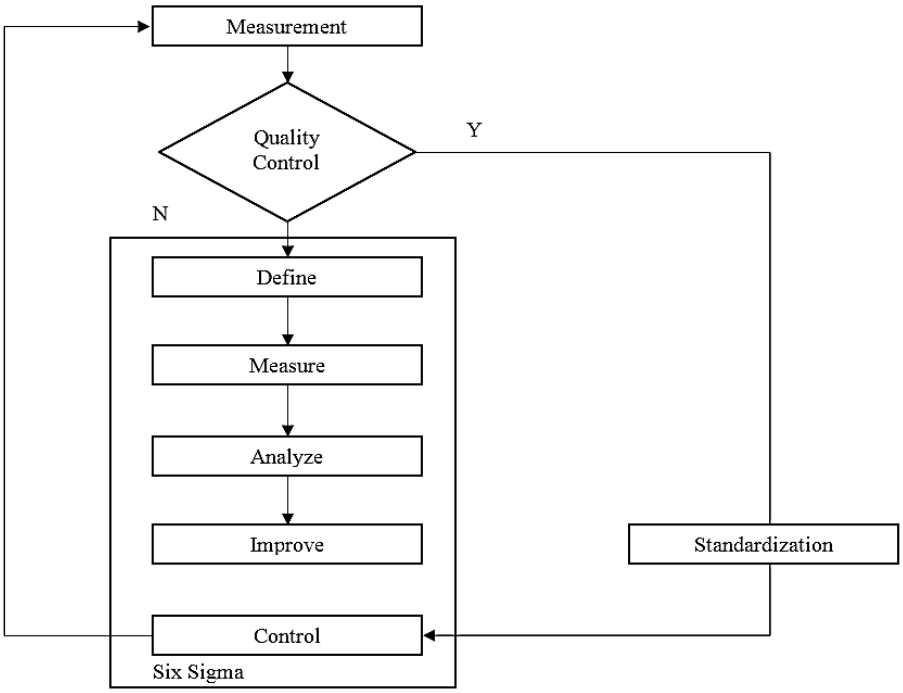


***Fig. 1.*** *Steps in the six sigma method.*

### *2.3 Benefits of Six Sigma*

There are several benefits of Six Sigma for companies [21], namely a) produce sustainable success, the way to continue growth and remain in control of the growth of a safe market is to continually innovate and re-create the organization [21]. Six sigma creates expertise and culture to constantly rise again. b) Set performance goals for everyone in a company, make everyone work in the same direction and focus on common goals [22]. Each function, business unit, and individuals have different goals and targets. Even so, there are things that everyone has inside or outside of change. Six sigma uses this to create a consistent goal. c) Strengthening value for customers with intense competition in every industry, only the delivery of quality or defect-free products and services does not guarantee success. Focusing on customers at the six sigma core means learning what values mean to customers and planning how to deliver them to them profitably [23]. d) Speed up the level improvements with information technology that determines the pace of steps, customer expectations for improvement are increasingly evident, and companies that make the fastest improvements are likely to win the competition. By borrowing tools and ideas from many disciplines, Six Sigma helps a company not only improve performance but also improve improvements [24]. e) Promote learning and "Cross-pollination" Six Sigma is an approach that can improve and accelerate the development and dissemination of new ideas in an entire organization [25]. People who are trained with expertise in many processes and how to manage and improve processes can be transferred to other divisions with the ability to implement processes more quickly. Their ideas can be shared so that performance is easier to compare. f) Do change strategies introducing new products, launching new partnerships, and entering new markets are daily business activities that are usually done by companies. By better understanding the processes and procedures the company will provide greater ability to make small adjustments or major changes demanded by business success.

## 3. Methodology

The research is a descriptive study that begins with a field study of the actual conditions that occur. The data used in this study are primary data from observations and interviews with parties in the field and secondary data from company documents, which are then processed again for the benefit of this research. The number of samples in this study is 100 with the sampling technique is random sampling using random number tables. This study will determine the value of DPMO and level six companies. Diagram Pareto is also made to find out the most dominant types of defects. The next step is to find out the causes of deviations in quality with fishbone diagrams. Overall, this study follows the steps of Six Sigma which includes define, measure, analyze, improve, and control (DMAIC).

Six Sigma Method: Six Sigma is a vision of quality improvement towards the target of 3.4 failure per million opportunities (DPMO) for each product transaction (goods and services). Therefore, Six Sigma can be said as an effort made towards perfection (zero defect), the stages of implementing quality improvement with Six Sigma consist of five steps, namely using the DMAIC or Define, Measure, Analyze, Improve, and Control methods.

- Define (Formulation) is the goal setting of six sigma quality improvement activities which is the first operational step in the Six Sigma quality improvement program.
- Measure is the second step in the Six Sigma-DMAIC quality improvement program. The main things to do in this case are: 1) determine key quality characteristics, here are quality characteristics or CTQ. 2) Measurement of performance baselines of quality characteristic attributes at the output level. Before a product can be declared defective or failed, the criteria for failure or disability must be defined first.

$$\text{DPMO} = \frac{\text{Total production defects x 1,000,000}}{\text{Also produce x CTO}} \quad (1)$$

Meanwhile, to get the sigma level value, it can be obtained from the DPMO conversion Table to Sigma values or use functions in Microsoft Excel,

$$= \text{normsinv}((1{,}000{,}000\text{-PMO})/1{,}000{,}000) + 1{,}5\ . \quad (2)$$

- Analyze (Analysis) is an examination of processes, facts, and data to get an understanding of why a problem occurs and where there is an opportunity to make improvements.
- Improve is an action plan to improve the quality of Six Sigma after the root cause has been identified.
- Control (control) is the last operational stage in Six Sigma projects. At this stage the results of quality improvement are documented and disseminated.

Pareto diagram: Pareto diagram describes the comparison of each type of data to the whole. By using the Pareto diagram which problem can be seen to be dominant so that it can know the priority of problem solving Pareto diagram function is to identify or select the main problem for quality improvement from the largest to the smallest. The use of the Pareto diagram is: a) show the main problem, b) state the comparison of each problem to the whole, c) show the level of improvement after corrective actions in a limited area, and d) show a comparison of each issue before and after improvement. Pareto diagrams are used to identify several important issues, to find the biggest and most influential defect. The most influential search for the biggest defect or defect can be useful to find some representatives of identified defects, then it can be used to create a causal diagram. This needs to be done considering it is very

difficult to find the cause of all identified defects. If all defects are analyzed to find the cause then it will only waste time and money in vain.

Cause and Effect diagram: The causal diagram is used to identify problems and find the source of the cause of quality problems, this diagram forms ways to make products better and achieve the results (results).

## 4. Discussion and Conclusion

This research was conducted by following the steps of applying the Six Sigma method, namely define, measure, analyze, improve, and control which includes define: a) problem: PT. XYZ sets several specifications of quality standards printed on magazines, in order to meet customer needs and satisfaction. But from these specifications there are still many prints that have not met quality standards. There are 3 (three) causes of the most defects in the production of this magazine, namely opaque ink color, the center fold position does not register with a deviation tolerance of 0.275 mm, and the newspaper sheet is cut off not fitting size, where the standard size of the machine cut-off is 56 x 75.3 mm. b) Objective: In order to produce quality printed magazines and reduce product defects, where the expected percentage of defects can be decreases close to 0%. So that consumers will be satisfied with the production of PT. XYZ. Measure: a) determine Critical to Quality (CTQ), CTQ is the main attribute of consumer needs. CTQ can be interpreted as an element of the process/activity that has a direct effect on achieving the desired quality. In PT. X there are 3 types of defects, which are blurred ink colors, middle fold position not registers, and newspaper sheets not cut according to size, b) performance baseline. Baseline measurement is intended to determine the extent to which a product can meet the customer's specific needs, before the product is delivered to the customer.

***Table 1***. *Frequency of magazine production disability.*

| Month | Amount of Production | Number of Production Defects | Percentage of Defective Products |
|---|---|---|---|
| January | 1780850 | 75500 | 4.23954853 |
| February | 1765350 | 80400 | 4.554337667 |
| March | 1750340 | 85500 | 4.884765246 |
| April | 1750325 | 78500 | 4.484881379 |
| May | 1725350 | 79500 | 4.607760744 |
| June | 1735320 | 83450 | 4.808911325 |
| July | 1690860 | 80320 | 4.750245437 |
| August | 1670900 | 80500 | 4.817762882 |
| September | 1680900 | 79650 | 4.738532929 |
| October | 1695350 | 86700 | 5.113988262 |
| November | 1730350 | 89900 | 5.195480683 |
| December | 1750500 | 89950 | 5.138531848 |
| Total | 20726395 | 989870 | |

***Table 2**. DPMO and sigma value.*

| Month | Amount of Production | Number of Production Defects | CTQ | DPMO | Sigma |
|---|---|---|---|---|---|
| January | 1780850 | 75500 | 3 | 14131.82843 | 3.693607249 |
| February | 1765350 | 80400 | 3 | 15181.12556 | 3.66533224 |
| March | 1750340 | 85500 | 3 | 16282.55082 | 3.63740455 |
| April | 1750325 | 78500 | 3 | 14949.6046 | 3.671423035 |
| May | 1725350 | 79500 | 3 | 15359.20248 | 3.6607015 |
| June | 1735320 | 83450 | 3 | 16029.70442 | 3.643669112 |
| July | 1690860 | 80320 | 3 | 15834.15146 | 3.648572508 |
| August | 1670900 | 80500 | 3 | 16059.20961 | 3.642933741 |
| September | 1680900 | 79650 | 3 | 15795.10976 | 3.649557673 |
| October | 1695350 | 86700 | 3 | 17046.62754 | 3.61896701 |
| November | 1730350 | 89900 | 3 | 17318.26894 | 3.612582266 |
| December | 1750500 | 89950 | 3 | 17128.43949 | 3.617034982 |
| Total | 20726395 | 989870 | 3 | 15919.63613 | 3.64642267 |

From the conversion results, DPMO shows that the sigma value of the production of this magazine is 3.6. The order of the number of defects per item/type of defect is as follows.

***Table 3**. Data on types of defects.*

| Month | Type of Defects (exemplar) | | | Total Defects |
|---|---|---|---|---|
| | Blur | Not Registered | Cut Off | |
| January | 49325 | 13215 | 12960 | 75500 |
| February | 45325 | 25315 | 9760 | 80400 |
| March | 51250 | 21750 | 12500 | 85500 |
| April | 51300 | 18500 | 8700 | 78500 |
| May | 51250 | 23500 | 4750 | 79500 |
| June | 49210 | 28700 | 5540 | 83450 |
| July | 47500 | 21300 | 11520 | 80320 |
| August | 40600 | 29800 | 10100 | 80500 |
| September | 49800 | 18700 | 11150 | 79650 |
| October | 51320 | 25300 | 10080 | 86700 |
| November | 45870 | 29700 | 14330 | 89900 |
| December | 49650 | 34750 | 5550 | 89950 |
| Total | 582400 | 290530 | 116940 | 989870 |

From the table above it can be seen that the largest random type sequence is Blur (59%), not registered (29%), and Cut Off (12%).

Then from the data on the type of defect, analysis is done using the Pareto diagram and cause effects diagram, as follows.

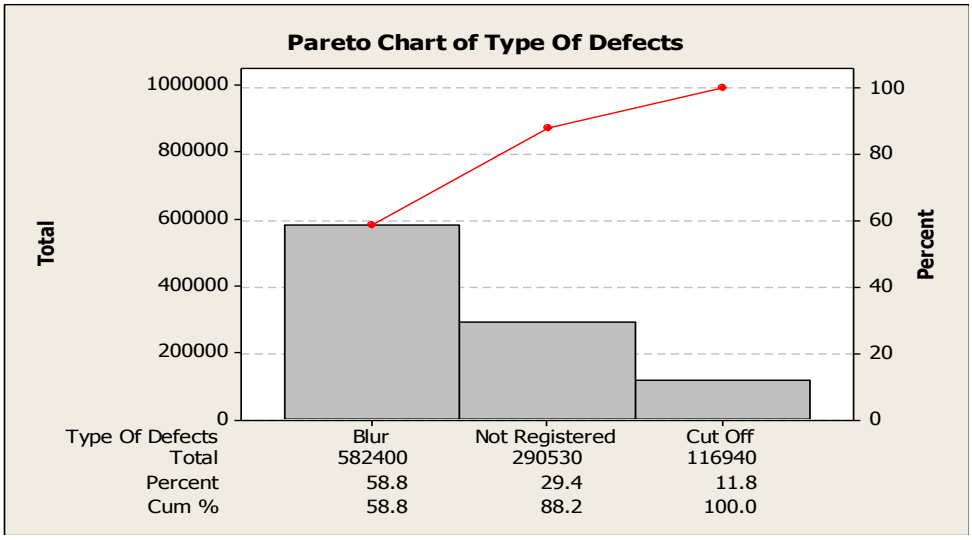


***Fig. 2*** *Pareto diagram analysis.*

Based on observation and analysis results, outline of a causal diagram can be made, stating the issue of the magazine.

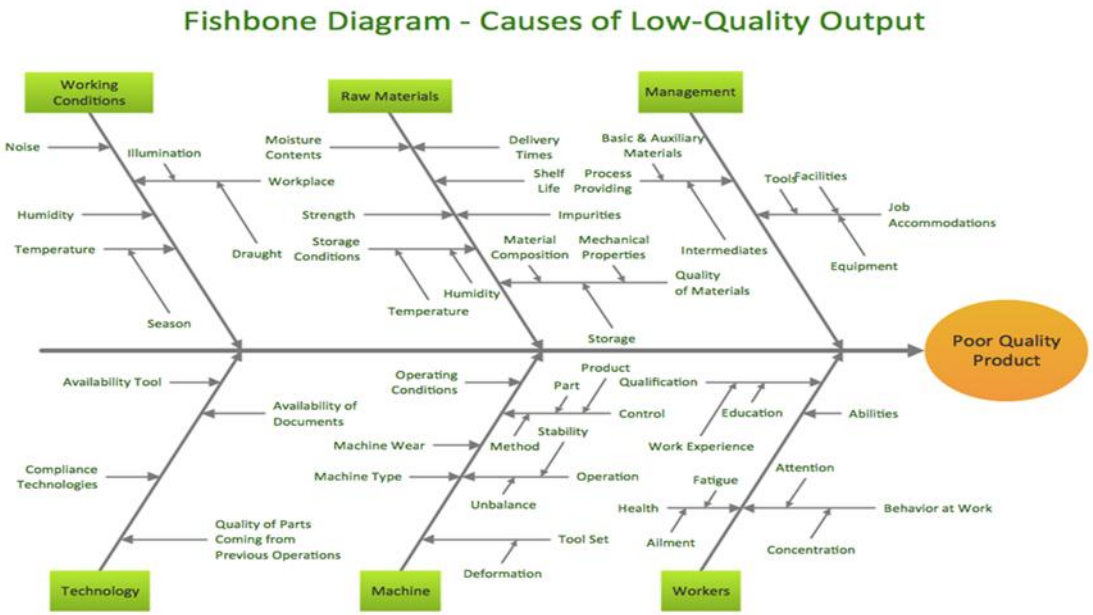


***Fig. 3*** *Causal diagram analysis.*

The conclusions obtained from this study are: The sigma level of PT.X is 3.6 with probable damage of 15919,63613 products in one million produced products. There are three types of defects in the production of magazine letters produced by PT.XYZ which is a blurry ink color, 582,400 (59%), not correct in the register of 290530 (29%), and newspaper cuttings of 116940 (12%). The main factor of the blurry ink color is the color setting of the engine that is less accurate, replenishing the ink volume on the color tank is not suitable for the quantity and the damage plate.

## 5. Research Limitations and Recommendations for Future Studies

With regard to the research methodology and conditions, some research limitations are as follows:

- The results of this study were confined to the population of research sample and they are not generalizable to other organizations.
- Research findings were confined to the time duration of data collection.
- In this study, confirmed data were used in designing the questionnaires of intellectual capital and organizational commitment.
- In this study, only the dimensions of intellectual capital were considered.

Also, with regard to the mentioned limitations, as the suggestions for improving production quality, some actions that can be taken to repair any blurry color defect types and no list and defective cuts, which include:

- Engine dimensions: a) check carefully the machine before use and after use b) prepare frequently replaced spare parts and perform regular maintenance.
- Human Resources: Improve the skills of employees by conducting training.
- Material: Checks raw materials received from suppliers according to the specifications used and separating materials that do not meet the standards.
- Method: Routine behavioral briefing to provide verbal and written instruction.
- Environmental element: Increase the facility in the production room to reduce the heat temperature due to engine and weather.

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