Review: Journal of Multidisciplinary in Social Sciences

Volume 02 No 01 January 2025
E ISSN : 3031-6375
https://lenteranusa.id/

Reduction of Dimension Out Defects in Electronic Products Using Process Control Methods with Fish Diagrams and FMEA

Hartono Hartono[1], Mohammad Rafi Pratama[2]; Muhammad Imam Hanafi[3]; Muhammad Nurali[4]; Yudi Prastyo[5]
[1,2,3,4,5]Universitas Pelita Bangsa
Email: tonohar261@gmail.com

Abstract
This research was conducted at PT. XYZ, a metal stamping company, to identify and mitigate dimension out problems. The research took place from August to October and used problem-solving methods such as Root Cause Analysis (RCA), Statistical Process Control (SPC), Fishbone Diagram, and Failure Modes and Effects Analysis (FMEA). The main problems identified were the inconsistency of operators in working and the frequent fluctuations of the machines used, which had a significant impact on the final production output. The SPC method is used to monitor process variations and identify deviation patterns. Fishbone Diagram helps in identifying the underlying causative factors of this problem, while RCA is used to dig deeper into the root causes. FMEA is applied to assess the risks associated with these variations and determine the priority of corrective actions. The results of the analysis show that variations in operator performance and engine turnover are often the main factors causing dimensional problems. Corrective measures implemented include operator retraining to improve work consistency, implementation of stricter standard procedures, and machine maintenance schedules to reduce the frequency of engine changes. The implementation of this action has succeeded in significantly reducing the frequency of dimension out and increasing the stability of the production process. This study concludes that the use of a structured and comprehensive approach in identifying and overcoming dimension out problems can improve product quality and production efficiency at PT. XYZ. Recommendations for continuous improvement are also recommended to ensure that the process remains stable in the long term and from the data collected, it can be seen that the largest contributor rejection is dimension out, namely the size of the product exceeding the specifications. If this size excess is too large to exceed the existing tolerances, it will greatly affect the yield in the assembly process. If found in customers, it will have a fatal effect on customer trust in the quality of the products produced. This can have an impact on the company's business interests.

Keywords: RCA, SPC, FMEA,Dimension Out, Production Quality

Introduction

The metal stamping production process is one of the important manufacturing methods in the metal manufacturing industry. Metal stamping involves the use of machines and tools to shape sheet metal into the desired shape and size through a series of processes such as punching, cutting, bending, and drawing. The success of this process is highly dependent on accuracy and precision in every step of production. However, one of the main challenges faced in metal stamping production is the problem of out-of-spec dimensions, where the resulting components do not meet the predetermined size specifications. This problem can be caused by a variety of factors, including material variations, gauge errors, and unstable machine operating conditions. The out-of-spec dimension can have a significant impact on the quality of the final product, production costs, and customer satisfaction.

This study aims to analyze the factors that cause out-of-spec dimensions in the metal stamping production process and develop solutions to overcome these problems. In this study, measurement data from various stages of production will be collected and analyzed to identify the source of variability and the main cause of out-of-spec dimensional problems. In addition, improvement approaches such as gauge calibration, process control, and operator training will be evaluated to improve accuracy and precision in metal stamping production. By understanding and overcoming the problem of out-of-spec dimensions, it is hoped that this research can make a significant contribution to improving the quality and efficiency of the metal stamping production process, as well as providing insights for the manufacturing industry in managing variability and ensuring compliance with product specifications.

In the production process, many repetitive problems are found in the product dimension. This problem causes a decrease in product quality and the potential for increased production costs due to the rework process, or the repetition of unwanted processes. Dimensions that do not meet specifications have an effect when parts are combined with other parts, which can result in customer dissatisfaction due to problematic parts. Some of the problems that affect the quality of the product include variations in size, physical defects, and non-conformity with the expected quality standards. Therefore, it is important to conduct a thorough investigation to find the root cause of this problem.

PT. XYZ is a metal stamping company that produces a lot of electronic parts. In the production process, many NG reject products were found with over spec dimensions. This study uses quantitative research methods to collect, analyze, and improve from the source of the cause of the problem in the metal stamping company PT. XYZ. This method was chosen to produce conclusions based on objective and statistically testable quantitative data.

Research Flow

The framework of this study aims to describe how quality control carried out statistically can analyze the level of product damage of PT. XYZ is still within the tolerance limit or not and identifying the cause of the problem is then traced so as to produce proposals to improve production quality in the future. Based on that, the research flow can be prepared as follows

Population and Sample

The population in this study is the number of rejections that occur in PT. XYZ which is produced for three months, namely August - October 2024. The sample used in this study is a saturated sample where all numbers or members of the population are used as samples.

Data Type

The types of data used in this study consist of secondary data and primary data which are data on the number of production and defective products, the data obtained is in the form of quantitative data. Quantitative data, namely data in the form of numbers, is data on the number of production and defective products, most of the data is obtained from the company where the research is placed. Quantitative data is obtained from documents/archives of the production department and the quality control department.

1. Field Survey
   To build a general understanding of the production process that is the focus of attention and the actual condition of how the process is carried out and monitored, field surveys are carried out directly.

2. Data Collection
   The rejected product data analyzed is production data in the period August – October 2024 as the output of the metal stamping process

3. Data Processing
   This stage is divided into several by referring to the 6 Sigma method which includes the stages of Define, Measure, Analyze, and Improve.

Define

At this define stage, the problem to be answered is determined by referring to production reject data. The total rejection obtained can then be divided according to the type of rejection. With the Pareto diagram, 20% of the problems in 80% of rejections can be identified. The main cause of this problem then became the focus of attention in this study

Measure

The steps at this stage are as follows:

1. Determination of sample count and normality test
   The minimum number of samples is determined by the equation where n is the number of samples, N is the size of the population. Meanwhile, the normality test was carried out using the Kolmogorov-Smirnov method.
   $$n = \frac{N}{1 + Ne^2}$$
2. Upper *Control Limit* (UCL) and *Lower Control Limit* (LCL) Calculation
   Because the product under study is calculated per *defective* unit and the sample size is taken constantly, a *control chart*: np-chart *is used*. In the np-chart, the calculation of UCL and LCL

values [11] is as follows:

$$UCL = n\bar{p} + 3\sqrt{n\bar{p}\,(1 - \bar{p})}$$
$$LCL = n\bar{p} - 3\sqrt{n\bar{p}\,(1 - \bar{p})}$$

where n is the fixed number in the sample subgroup and $\bar{p}$ is the average of the proportion of *defective units*.

3. Determination of the value of the process capability index (CPK)
   By comparing the minimum distance of the midpoint to the nearest specs limit limit to the value of 3 σ(the natural tolerance of a normally distributed process), the value of the process capability index can be calculated by the formula:
   $$CPK = \frac{Sigma\ Leve}{3}$$
4. Analyze
   In this stage of analysis, the problems that are the focus of improvement will be reviewed in more detail by doing:
   a) Fishbone diagram that facilitates the review of problems from a broader perspective which includes factors: Man, Machine, Method, Material, Environment. Fishbone diagrams are carried out through the brainstorming process of the functions involved in the process that are the focus of the research.
   b) Failure Mode and Effect Analysis (FMEA) which is a reference in mapping the potential for failure, because of failure and the high and low risk of events with the results of the Risk Priority Number (RPN) value calculated based on the results of multiplication of justification values for Severity, Occurrence and Detection as follows:
   $$RPN = severity.occurance.detection$$
5. Improve
   This stage refers to the ranking of RPN values obtained from FMEA at the analyze stage. Recommendations for proposed improvements can be in the form of technical actions, improvement of procedures, improvement of operator capabilities, maintaining the quality of raw materials, or improvement of the work environment in general

Method

Data Collection

The collection of production process data starts from August-October. The data collected includes the number of outputs, the number of OK and NG Parts, and the data of emerging problems.

Stastistic Process Control (SPC)

Statistical Process Control. It is a method used in quality management to monitor, control, and improve a production or service process through statistical analysis.

Review: Journal of Multidisciplinary in Social Sciences

Volume 02 No 01 January 2025
E ISSN : 3031-6375
https://lenteranusa.id/

Fisbone Diagram

Fishbone Diagram or Ishikawa Diagram or Causal Diagram, is a quality management tool used to identify, analyze, and visualize the root cause of a particular problem or effect. This diagram is called "fishbone" because its shape resembles a fishbone.

Failure Mode and Effect Analysis (FMEA)

Failure Modes and Effects Analysis (FMEA) is a systematic method used to identify and analyze potential failures in a product or process and determine the impact of those failures. FMEA helps in determining preventive measures to reduce or eliminate the risk of failure. This method is very useful in improving product quality and reliability and minimizing risks associated with the production process.

Results and Discussion

The stamping process of electronic parts production is shown in the following figure 1:

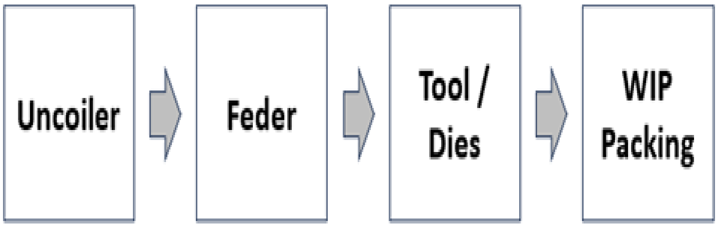

Figure 1. Stamping Process Block Diagram

Briefly explained as follows: the material in the form of a coil becomes an input to the uncoiler process. Furthermore, the output of this process will be the input for the feeder machine. The output of the feeder machine is in the form of flat material. After that, the flat material will be processed such as warping, coining, making holes and cutting automatically in the tool dies process. The output from the machine tool dies will be the final product which will then be sent to the WIP storage section waiting for the next process.

FasevDefine

From the results of observations on production data for three months (August-October 2024), it shows that the types of rejections that often occur include dimension out, dented, dented, wrong positon, and missing processes with the distribution of findings in each category as shown in the following table:

Table 1. Reject Distribution by Category

Types of Difect	Quantity Pcs	Percentage (%)
Dimension Out	282	57%
Scratch	88	18%
Dented	72	15%
Wrong	32	6%
Missing	20	4%
Total	494	100%

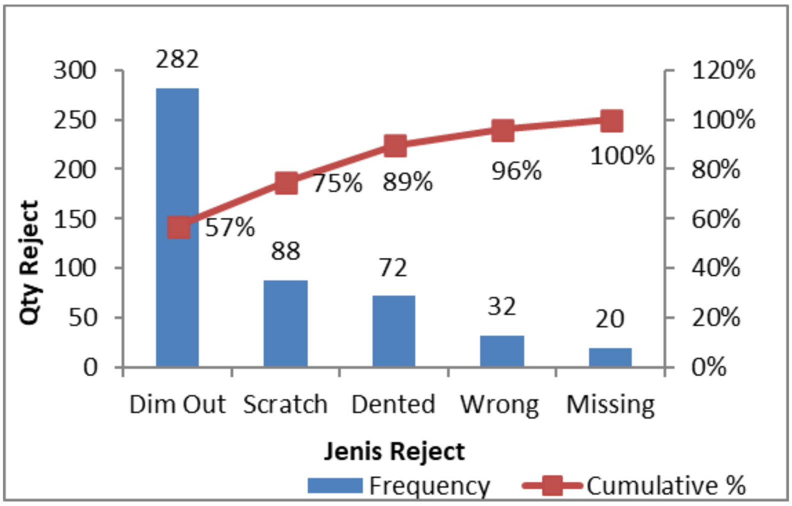

Figure 2. Pareto Diagram of Reject Type Metal Stamping Process

As a follow-up to the findings in the define phase where the problem that will be the focus of improvement is to reduce or eliminate the dominant type of rejection, namely the out dimension. Therefore, the formulation of this problem needs to be verified in the form of measurement results in the measure phase.

Phase Measure

Sampling and normality test

Because the data that represents the population in this study is production data for 3 months (August – October 2024), which is 1,200 pcs, then with equation 1 it can be calculated that the estimated number of samples needed is 320 pcs. With a production system of 2 shifts every day (@8 hours/shift) and each sampling is taken as many as 4 pcs/hour, 64 pcs/day of sample data can be collected. So the time needed for sampling data collection in total is approximately 5 days with measurement results as shown in Table 2 below:

Table 2. Sampling of Normality Test

Day to	Number of samples	1	2	3	4	Total Defects
1	64	2	2	0	1	4
2	64	3	1	2	0	6
3	64	1	0	1	2	4
4	64	2	1	0	0	3
5	64	0	1	1	0	2
Total	320	11	5	4	3	23
Percentage	-	48%	22%	17%	13%	100%

1. Dimension Out
2. Scratch
3. Dented
4. Wrong
5. Missing

Furthermore, the Upper Control Limit (UCL) and Lower Control Limit (LCL) of the np chart can be calculated using formulas 2 and 3. From the calculation in it can be UCL = 7.8; CL = 4.4 and LCL = 0. By referring to the data in Table 2, especially on the number of rejections from the largest data, namely dimension out, it can be concluded that this process is controlled because the value of the number of rejections is in the range of LCL and UCL as shown in the following figure 3:

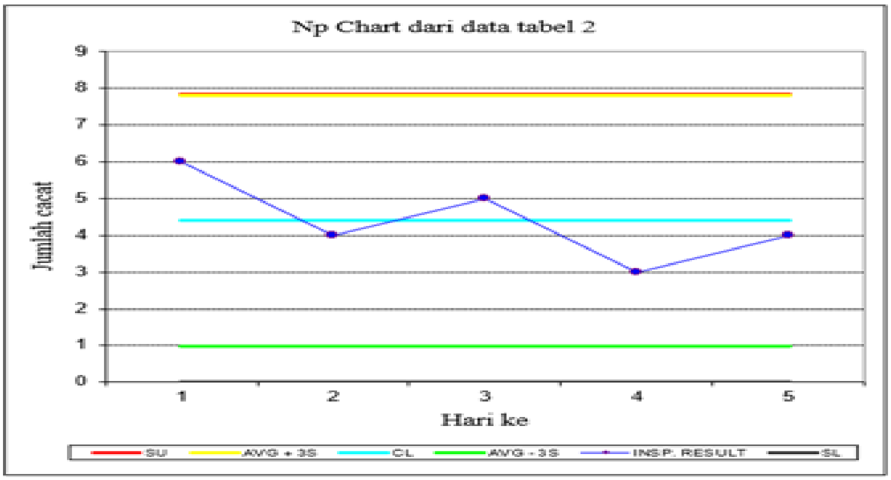

Figure 3 : Np Chart Flaw Dimension Out

Measurement of Process Capability Index (Cpk)

From the 3rd formula, the Cpk value of this process is 1.01. By taking into account the rejection contribution of the dimension out type in Table 2, the estimated final yield is 1- 0.02 = 0.98 = 98%. These two parameters indicate that the performance of this metal stamping process is in the moderate category. This indicates that companies need to seek more effective and decisive ways to control the process so that the Sigma level can be improved.

Analyze Phase

From the data collected, it can be seen that the largest contributor to rejection is dimension out, which is the size of the product exceeding the specifications. If this size excess is too large to exceed the existing tolerances, it will greatly affect the yield in the assembly process. If found in customers, it will have a fatal effect on customer trust in the quality of the products produced. This can have an impact on the company's business interests.

Given the importance of the impact that can be caused if the process is not controlled, this type of out dimension reject needs to be analyzed at the root of the problem using a fishbone diagram. The causes of this out dimension problem are grouped into several factors, namely man, machine, method, measurement, material and environment. From the results of brainstorming carried out with the production team, technicians, engineers and quality inspectors, the following details of the explanation were obtained:

1. Human Factor (Man)
   There are three things that are considered to be the factors that cause the failure of this process caused by human factors:
   a) The operator does not check the product carefully other than the sampling check carried out by QA personnel
   b) The operator does not fully understand the specifications of the product being worked on
   c) operators do not understand the SOPs of the production process so they have the potential to make mistakes in setup and handling procedures.
2. Machine Factor

In the metal stamping process which consists of a series of processes involving several different types of machines, each has special sensors to ensure that the process can run according to the ideal setting. If the feeding material is unstable, the continuity of the process will be disrupted. This is caused by a faulty misfed sensor. In the end, it will also affect the quality of the product in terms of the precision of the dimensions produced. In addition, in this feeder process, roller marks are also prone to occur which is caused by a malfunctioning slugmark sensor. Furthermore, what often occurs is over bending caused by an imprecise bending tool.

3. Method Factor

Reject dimension out can also be caused by operating methodology factors and/or incorrect parameter settings during the implementation of the production process. The following are the root of the problems collected by the team: 1) the wrong SPM setting method; 2) wrong die height setting method; 3) incorrect detection method of wind pressure changes; 4) Incorrect oil flow regulation method.

4. Material Factors

In the context of rejecting the out dimension, the material handling factor is quite significant considering the frequent misuse of the type of material and the dimensions of the raw material that should be used, such as the use of thicker materials. This leads to failures in the processing of these materials, one of which is in the form of out dimensions. In addition, this can also be fatal because material debris can enter the tool dies so that it will affect the quality of the cutting process.

5. Environmental Factors

That the metal stamping process generates a high level of noise and heat transferred from the machine to the environment has made the operator's conditions uncomfortable. In addition, it is very risky in the production process that is carried out at night. Fatigue followed by a decrease in concentration can trigger unnecessary mistakes and even work accidents.

Conclusion

This study succeeded in identifying and reducing the problem of dimensional defects in electronic products at PT. XYZ uses quality control methods, such as Statistical Process Control (SPC), Fishbone Diagram, and Failure Modes and Effects Analysis (FMEA). The main factors causing the problem are inconsistencies of operators and frequent machine changes, which affect the dimensional quality of the product. Corrective actions implemented include:

1. Retrain operators to improve work consistency.
2. Implementation of stricter standard procedures.
3. Machine maintenance schedule to reduce the frequency of machine changes.

The results show a significant decrease in the frequency of dimensional defects and an increase in the stability of the production process. This structured approach has a positive impact on the company's product quality and production efficiency. Recommendations for continuous improvement are recommended to maintain process stability in the long term. The research also emphasizes the importance of maintaining product quality to maintain customer trust, which contributes to the sustainability of the company's business.

References

A. Anastasya And F. Yuamita. (2022). Quality Control in the Production of Drinking Water in 330 ml Bottles Using the Failure Mode Effect Analysis (Fmea) Method at PDAM Tirta Sembada. Jtmit, Vol. 1, No. I

Bayu De Wanda Putra, Elly Ismiyah. (2024). Quality Control Analysis on the Drumming Process of Pt. Abc White Oil Using Six Sigma and Fmea Methods. Journal Of Information Technology And Computer Science (Intecoms) Volume 7 Number 6

Budi Antoro, Dewi Wahyuni, M. Reza Septriawan. (2023). Application of Control Process Statistics (SPC) as a Learning Evaluation Tool. Volume 7 Number 3

Cicilia Sriliasta Bangun, Arif Maulana, Roesfiansjah Rasjidin, Taufiqur Rahman. (2022). Application Of Spc And Fmea Methods To Reduce The Level Of Hollow Product Defects. Journal of Research Results and Scientific Works in the Field of Industrial Engineering Vol. 8, No. 1

Hanifah, P. S. K.., & Iftadi, I. (2022). Application of Six Sigma Method and Failure Mode Effect Analysis to Improve Quality Control of Sugar Production. Journal of Intech Industrial Engineering, University of Serang Raya, 8(2), 90-98.

Harini Fajar Nigrum. (2019). Product Quality Control Analysis Using the Statistical Process Control (SPC) Method at Pt Difa Kreasi. Bisnisman Journal: Business and Management Research Vol. 1, No. 2

Hernawan, A., & Mahbubah, N. A. (2021). Integration of Statistical Process Control and Failure Mode and Effect Analysis to Minimize Defects in the Production Process of PVC Pipes. Journal of Engine: Energy, Manufacturing, and Materials, 5(2), 65–76.

Heryanto Parlinggoman, Sabariman. (2020). Analysis of Quality Improvement of Metal Stamping Process Using the Six Sigma Method. Volume 1 Number 1

Nanih Suhartini. (2020). Application of Statistical Process Control (SPC) Method in Identifying the Main Factors Causing Defects in the Production Process of ABC Products. Scientific Journal of Technology and Engineering Volume 25 No. 1

R. Elyas and W. Handayani. (2020). Statistical Process Control (SPC) for Quality Control of Furniture Products in Ud. Ihtiar Jaya. Journal of Management, Vol. 6 No. 1

Sri Mukti Wiranti. (2019). Analysis of Quality Control of Plastic Bottle Packaging Using the Static Process Control (SPC) Method at Pt.Sina Sosro Kbp Pandeglang. Journal of Intent, Vol. 2, No. 1,

Wirawati, S., & Juniarti, A. (2020). Quality control of carded yarn products to reduce defects by using Failure Mode And Effect Analysis (FMEA). Journal of Intent: Journal of Integrated Industry and Technology, 3(2), 90 - 98.

Zeri Yusdinata, M. Ansyar Bora, Nurul Arofah. (2018). Analysis of the Implementation of Occupational Safety and Health (K3) Using the Fishbone Diagram Method. Vol. 3 | No. 2