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REDUCTION OF BOLT PRODUCT DEFECTS AT PT. GIP USING SIX SIGMA METHOD

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OUTLINE

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INTRODUCTION

- Every company must continue to increase the output produced, so that it really needs management that is competent in its field.
- To maintain production quality, company management must pay attention to the order of each production process itself, because each production line has an interdependent relationship **(Suwandi, Zagloel, and Hidayatno 2021).**
- PT. GIP is a company that manufactures Fastener products in Indonesia whose production system is based on order, several Fastener products such as: Self Drilling Screw, Drywall Screw, Rivet, Furniture Screw, Tapping Screw, Special Screw, Hi Lo Furniture Screws, Bolts , Chipboard Screws, Automotive Screws.
- The company's current problem is the number of defects that occur in the production process of bolt products, such as thread defects that are less precise, bolt head sizes that are not symmetrical, cracks and lack of length. This resulted in decreased sales levels and high costs for handling customer complaints.

OBJECTIVES

- Improving production quality in overcoming bolt product defects.
- Analyze and determine the factors that cause defects in the production process, determine the current value of DPMO (Defect Per Million Opportunities) and the level of sigma.
- Provide recommendations for improvement in overcoming defects in bolt products.

The contribution of this paper provides ways on how to overcome bolt production defects in the manufacture of nuts and bolts.

RESEARCH METHODS

This study uses the six sigma method to overcome the problem of handling product defects from variations in the types of defects in the production process.

The six sigma method consists of define, measure, analyze, improve and control stages

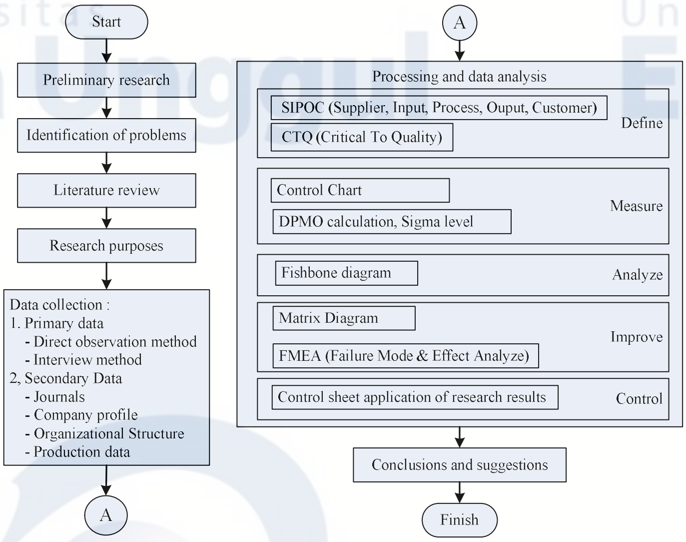

Figure 1. *Research flow chart*

RESULTS

The research was conducted in the production section PT. GIP, located in Tangerang, Indonesia. The data used in this research are loading time, downtime, total production, total defects and cycle time. The research was carried out in the cutting line.

Define Stages

SIPOC

The SIPOC diagram is a diagram depicting a company which includes Supplier, Input, Process, Output, Customer. Seen in the process consisting of 4 stages of the machine, this process is the focus of research.

SUPPLIER	INPUT	PROCESS	OUTPUT	CUSTOMER
PT. Krakatau Steel	MATERIAL Steel Wire	Heading Machine → Rolling Machine → Plating Machine → Packing	*Bolts*	– PT Kawasaki – PT Astra Otoparts

Figure 2. SIPOC

Critical to Quality

- Critical to Quality (CTQ) is the main attribute data to pay attention to because it relates to the quality of the products produced **(Costa, Lopes, and Brito 2020)**.
- The results of the observations show (CTQ) Critical to Quality in the Bolt production process.

Table 1. Critical to Quality (CTQ) Bolt Products

No.	Critical to Quality (CTQ)	Kind of Defect
1	Level of product flatness	Thread
2	Surface perfection	Dimensions
3	Product strength	Cracked

Table 2. Defect Type Data

Kind of Defect	Frequency
Dimensions	442
Cracked	210
Thread	91
Total	743

Measure Stage

Pareto Chart

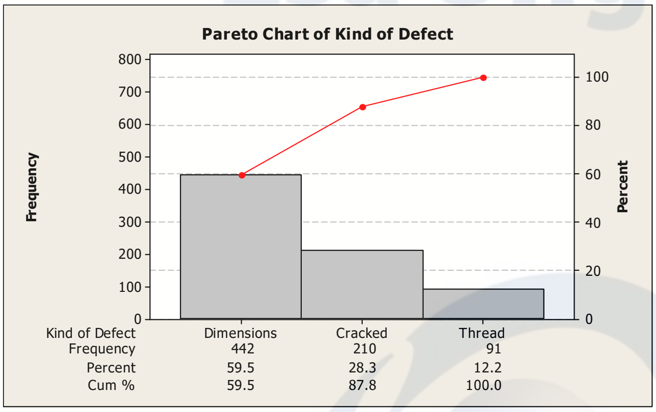

Figure 2. Pareto Chart

- Pareto chart is a bar chart that lists the types of defects that occur from largest to smallest (highest to lowest frequency). It can be seen in table 2, the most dominant type of defect occurs in the type of dimensional defect, namely the number of defects of 442 pcs.
- the type of dimensional defect has the highest frequency of 59.5%. So that dimensional defects are the main priority problems that must be resolved.

Control Chart (P-Chart)

P-Chart is a map that measures the proportion of defects in items that occur in a subgroup that is being inspected based on attribute data. The P control chart is used because the defect data for Bolt production is attribute in nature.

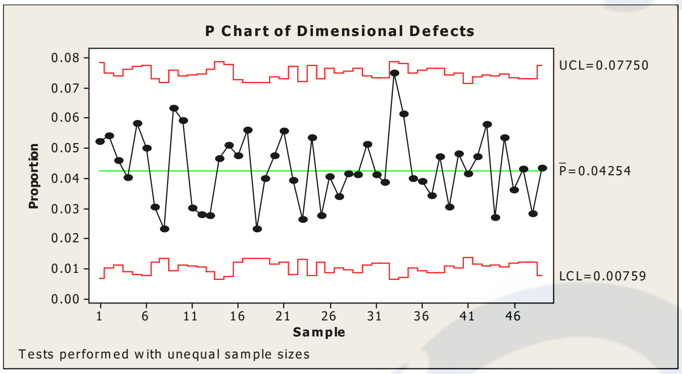

Figure 3. P-Chart of Dimensional Defects

Overall, the calculation results and using the minitab software obtained a P-Chart, which is presented in Figure 3.

There is one data that is close to the predetermined control limit, namely data on day 22, this is because at that time the operator had to work overtime so that the operator felt tired and unfocused which resulted in a significant increase in the defects caused.

Calculation of DPMO and Sigma Level

- The DPMO indicates the probability of a defect occurring for every one million events(Zhu et al. 2019).
- the value of DPO (Defect Per Opportunities) in the first day period is 0,017421602
- The Sigma value of the Bolt production process at PT. GIP is 3.6993.

Diagram Fishbone (Cause and Effect Diagram)

- A fishbone diagram is a formal tool used to identify potential causes of problems that occur (**Alhuraish, Robledo, and Kobi 2017**).
- The aim is to determine the factors causing defects obtained from direct observations on the production line and interviews with the production section of Bolt products.

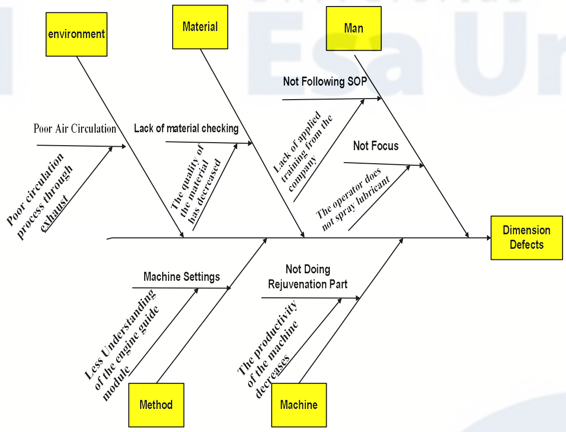

Figure 4. Fishbone Diagram Dimensional Defects

Man Factor

- Operator not focus

There are still operators who do not focus on work such as chatting, this can happen due to fatigue due to the absence of overtime hours, where the operator's obligation to work is only 8 hours a day, but the operator works for 12 hours.

- Not Following SOP

One of the company's SOPs is for operators to carry out maintenance, but in practice this is not done.

Machine Factor

From the results of interviews with the head of the maintenance department, the machine factor is the passage of time for the use of machine components so that it can have an impact on machine performance which triggers a decrease in production quality. Absence of engine rejuvenation with inadequate or inadequate level of maintenance results in decreased engine performance.

Material Factor

From the results of interviews with the inventory, the factors that cause dimensional defects in bolt products are due to lack of material checking and lack of attention to material storage space which causes the material to be at risk of rust.

Method Factor

From the results of interviews with the head of production, the method factor that causes defects is the machine setting which is often wrong by the operator because the procedure is not understood by the operator.

Environmental factor

The exhaust does not function normally, so the air circulation in the room is not smooth. With conditions like this will affect the settings that are less precise / accurate.

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Dimensional Defect Analysis with Matrix Diagram

- The matrix diagram serves to determine the critical to quality (CTQ) of each of the factors causing dimensional defects that have been obtained from the fishbone diagram.
- Critical to quality is a critical cause that affects product quality(Shalaby and El-sayed 2018).
- The priority scale of each causal factor can be known so that the analysis can be more focused. Before making the matrix diagram, the questionnaire was distributed to the competent divisions or divisions, namely the head of production, PPIC, Quality Control, Maintenance, Engineering.

Table 4. Critical To Quality Determination Matrix Diagram

Factor	Factors Causing Dimensional Defects	Stakeholders				Proportion of Defects	Critical to Quality
		Production	Maintenance	Quality Control	PPIC		
Operator	Not Following SOP	4	4	4	4	16	CTQ
	Not focus	2	2	3	3	10	-
Material	Lack of Material Check	3	4	3	3	13	CTQ
Machine	Decreased Engine Performance	3	3	2	2	10	-
Method	Machine Settings	4	3	4	4	15	CTQ

There are 3 factors that cause dimensional defects that fall into the CTQ category, and the recommended treatment

1. Not Following SOP

Hold a training agenda for employees to better understand the procedures set by the company and for the leadership to monitor every employee in the production line so that employees comply with the regulations set by the company.

2. Lack of Material Check

The selection of raw materials used must be considered better with the specifications set by the company and must pay more attention to the raw material storage space so that the quality of the raw materials is maintained and protected from corrosion (rust), so that the products produced are in accordance with the provisions of the company and consumers.

3. Machine Settings

The adjustment on the machine must follow the cutting adjustment guidelines set by the company so that the cutting results are stable and the product meets the specifications of the company and consumers

DISCUSSION

FMEA (Failure Mode & Effect Analyze)

- FMEA (Failure Mode and Effect Analysis) is a method to define and identify in detail the potential causes of failures that occur by taking into account the risk value of the potential failure, where the priority of repairs is carried out based on the order of the RPN (Risk Priority Number) values(Suwandi, Zagloel, and Hidayatno 2020).

FMEA Analysis and Proposed Improvements

- RPN 320, This failure mode can be caused by humans (operators) who do not follow the SOP, there are factors of negligence on the operator such as a lack of checking blade components which causes the bolt production results to not match those determined by the company
- The advice given is to provide training/training on the standard order of the product manufacturing process, tighten supervision of operators who are working and limit overtime hours.
- After making improvements in the improve phase, it appears that the number of product defects is decreasing, thus increasing the company's sigma level to 3.8457 based on the results of calculations as in the measure phase.

CONCLUSION

- The number of defective bolt products is 743 pieces with an average DPMO value of 704810.4874, and a sigma value of 3.6994. After improvement, the sigma value increased to 3.8457.
- The dominant defects in Bolt products are 442 dimensional defects. The contributing factors include: human factors (production operators do not follow the SOP and do not focus), machine factors (machine age), material factors (lack of material checking), method factors (machine settings), environmental factors (poor air circulation).
- Improvements that need to be made are on the human aspect, and at the control stage requires strict supervision from the company so that it can minimize the occurrence of defective products. Control measures taken are:
  i) During the production process, lubrication is carried out on the blade components periodically, so as to produce products that meet the criteria.
  ii) In the cutting process, the maintenance department checks and replaces blades regularly so that the cutting results are in accordance with company standards. Substitution of blade components must have high accuracy, because the level of sharpness of the blade in the cutting process greatly affects the product printing process.

Conclusions (Continued)

iii) The selection of raw materials used must be of high quality and meet the specifications set by the company, and pay more attention to storage space so that the quality of raw materials is maintained and protected from corrosion.

iv) The setting of the machine must follow the cutting regulation guidelines determined by the company so that the resulting cuts are precise and produce dimensionally defect-free products, in accordance with company and consumer criteria.

v) Perform periodic calculations of DPMO and sigma values each period to determine the ability of the process to produce perfect products per one million opportunities, in addition to calculating control charts to determine process stability periodically every period.

- Recommendations are in the form of standard training on the sequence of product manufacturing processes, tightening operator supervision and limiting overtime hours. Fill out check sheets for repairs. Furthermore, monitoring production quality reports continuously with evaluation before and after repairs.

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Untuk mendiseminasikan hasil penelitian yang telah dibuat pada **"13th International Seminar on Industrial Engineering and Management (13th ISIEM)"** yang diselenggarakan pada 28 Juli 2021.

Demikian surat tugas ini dibuat untuk digunakan sebagaimana mestinya.

Jakarta, 15 Juli 2021
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