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Optimal Level Setting to Reduce Disabled Seat Bear in Spraying Machines using Taguchi Method

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Abstract

Various efforts were made to improve quality, but sometimes things that occur during production processes such as defective products made the productivity of the company less than optimal. Defective products are products that have spent a lot of production costs but do not generate profits for the company. Various efforts were made to control the production process, such as improving the production system and finding why the product became defective by looking for influential factors in the production process. The Analyzed characteristics of quality include Phenumetic wind pressure, Wind Tank pressure, and dryer temperature. What is done after field observations was data processing using SNR, ANOVA, and interpretation of results? A combination of factor A2 B2 C1 was obtained compared to the condition of the company, namely A1 B1 C2, and got a loss of Rp 566,480.

Keywords: *Taguchi, Level Setting, Spraying*

I. INTRODUCTION

Quality in the industry is a thing that has a significant role because, in production, quality is one part of the selling price. Quality in the product can show survival to be able to compete in a company. Companies engaged in manufacturing continue to make continuous quality improvements. Today the industry in the manufacture of motorcycle tire products with high productivity output is identified as defects during the production process that make the company's productivity not optimal, resulting in unmet demand from the company, which is the demand from customers. Defective products are products that have cost a lot of production costs but do not generate company profits. The motorcycle tire manufacturing industry is assumed to provide a minimum target for defect goods below 5% of the total production in one month. Found in the field, Products often experience defects when the product enters the spraying machine. Spraying machine is a liquid tire lube spray machine that is not sticky during the tire cooking process. The product defects that occur in the spraying machine there are several types of defects, namely: Seat Bear defect, Foright mater spraying, and Bladder defects, which can be seen in the tables and diagrams below: Disability of Seat Bear (SB) is the most significant disability. Seat Bear is a broken joint in the polycord joint.

Table 1.1 Types of defects in spraying machines

Type of defect	Total	Percent
	Pcs	%
FMS	1380	17.56
BCA	840	10.69
SB	5640	71.76
TotalDefect	7860	100

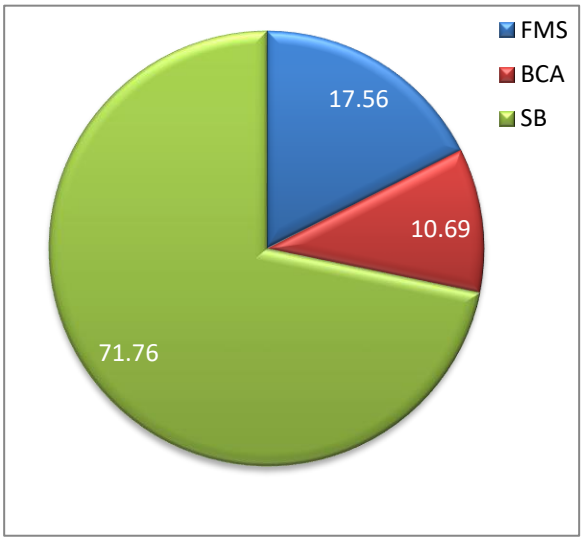

Figure 1.1 Pie Diagram of Spraying Machine Defect

Several factors affect the defect in spraying machines: tank wind pressure, pneumatic wind pressure, and drying. Spraying machine improvements are made to be the factors that influence the weakness of the product. From the background and identification of the problems described above, the formulation of the problem is how to determine the optimal level setting to reduce product defects that enter the spraying machine. Determine the factors that influence the product defect in the spraying process, select the optimal level spraying settings from the factors that influence the

spraying machine, and calculate the loss function at optimal conditions.

II. LITERATURE REVIEW

Data processing uses two variance analysis (ANOVA), consisting of analysis of mean and analysis of the signal to noise ratio (SNR). A confirmation experiment is conducted to test the predictive value of factor level settings at optimal conditions [1]. Quality is one of the main reasons for consumers to choose a product. Quality plays an essential role in improving the quality of the products produced and their benefits to consumers. Consumers will select products that are under the expected quality and the benefits obtained [2]. By applying the Taguchi method, the optimal level setting results are obtained [3]. The Taguchi method is a new methodology in engineering that aims to improve the quality of products and processes, minimize costs and time [4]. The most important part of the Taguchi method is that it determines the orthogonal array, located in selecting the combination of levels from the input variables for each experiment [10]. The Taguchi method is through experiments with orthogonal matrix arrays [6]. The technique used is the Taguchi Analysis Method to provide recommendations for appropriate corrective actions. The results of Taguchi analysis are processed using the S / N ratio and analysis of variance [7]. The company has difficulty in reducing the defect rate of the product, is what underlies the research with the Taguchi method, which aims to reduce the level of product defects [8]. Aguchi method is an effort to improve quality known as the off-line quality control method due to the quality design method in each process, and the product is appropriate. The Taguchi method is a quality improvement with the effort of a "new" plan, meaning that taking a different approach gives the same trust as SPC (Statistical Proces Control) [9].

A. Quality According To Taguchi

The design quality, according to Taguchi, has two general aspects, namely the quality of the design and the quality of compatibility. Quality design is a variation in the level of quality that exists in an intentional product. Match quality is how well a product conforms to specifications and allowances adjusted by design. The quality of compatibility is influenced by many factors, including selecting the process of making, training, and supervising. The type of quality assurance system (process control, testing activities, etc.) is used to what extent this quality procedure is followed and work motivation to achieve quality.

B. Taguchi Method

The Taguchi method was triggered by Dr. Genichi Taguchi in 1949, who was given the task of improving the communication system in Japan. The Taguchi method was an off-line quality control method, which was quality control by paying attention to produce a design or to make improvements in product design. He developed the Taguchi Method to make quality improvements with new experimental methods, meaning to take another approach that provides the same level of confidence as statistical process control.

C. The Stages of Product Design According To Taguchi

In the Taguchi Method, there are three stages to optimize product design or production process, namely:

1. System Design (system Design)
   It is the first stage in making new products or process innovations. Concepts come from previous experiments, natural knowledge/techniques, recent changes, or combinations. This stage is to get new ideas and pour in new products or process innovations.
2. Design parameters (Design Parameters)
   This stage is a physical creation or mathematical prototype based on the previous step through statistical experiments. The aim is to identify parameter settings that will give an average performance to the target and determine the effect of the interference factors on the version and target.
3. Design Tolerance (Tolerance design)
   Based on the Parameters related to community losses, tolerance is determined due to product deviations from the target.

D. Characteristic of Quality

Each product is designed to produce specific functions. Some measurement characteristics usually show quality characteristics. Quality characteristics are used to express the extent to which a product performs its function. In many cases, quality characteristics are generally a single measurement quantity such as weight, length, time. Quality characteristics are the result of a process related to quality. Measured quality characteristics, according to Taguchi, can be divided into three categories:

1. Nominal is the best
   Quality characteristics that lead to an appropriate target value at a point specific values, which fall under this category are weight, length, width, density, thickness, diameter, area, speed. The loss function is the best.
2. Smaller the better
   Achieving characteristics if getting smaller (close to zero) is getting better examples that include this category are machine use, percent, contamination, obstacles, irregularities, noise, failed products, processing time, response time, damage, energy waste. The loss function

is smaller, the better; this character type has a target equal to 0.

3. Larger is better

Achieving more significant quality characteristics is getting better. Examples of these characteristics are strength, tensile strength, efficiency, time, damage, corrosion resistance. The larger, the better the loss function; the characteristic type has a target with infinite value.

III. METHODOLOGY

Data collection and processing were carried out to include primary data, including the results of interviews, observations and direct observations and indirect observations, and secondary data, namely company data. Direct observation has: With the stopwatch method and the work sampling method (work). Many factors need to be considered so that a reasonable time to do work can be obtained, such as those relating to working conditions, methods of measurement, number of measures, and others. The steps that need to be followed so that the work measurement objectives can be achieved, among others

- determining the measurement objectives, conducting preliminary research,
- selecting operators, outlining the work on the elements of work and
- preparing measurement tools.

IV. DATA COLLECTION AND PROCESSING

Data collection and processing that includes primary data include interview observation and direct observation and secondary data, namely data from the company.

A. Selection of the Orthogonal Array

Because in this study, there are two independent variables (factors) where each independent variable has two levels, and the degree of freedom is 1, then the orthogonal matching is L4. At the same time, OA L4 can be seen in the table:

Table4.1Ortogonal Array L4 (OA L4)

Trial	Column Number		
	Pneumatic	Wind tank	Dryer
1	1	1	1
2	1	2	2
3	2	1	2
4	2	2	1

Average Factor Effect Data Processing

A1. $= \frac{30+35+35+38}{4} = 34, 5$

A2. $= \frac{40+41+50+51}{4} = 45, 5$

B1. $= \frac{30+35+40+41}{4} = 36, 5$

B2. $= \frac{35+38+50+51}{4} = 43, 5$

C1. $= \frac{30+35+50+51}{4} = 41, 5$

C2. $= \frac{35+38+40+41}{4} = 38, 5$

Response Table for Means

Level	A	B	C
1	34,50	36,50	41,50
2	45,50	43,50	38,50
Delta	11,00	7,00	3,00
Rank	1	2	3

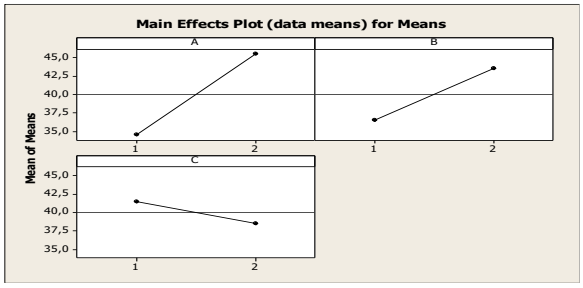

Figure 3.1 Response Graph for the average value of the Taguchi experiment

B. Changing Experimental Data to S/N Ratio

The quality characteristics of the number of bear seats are smaller is better, the calculation of the S / N ratio and the calculations are as follows:

$$S/N = -10 \log \frac{1}{r} SS_T$$

Calculation of Ratio *S/N*

$$S/N = -10 \log \frac{1}{r} SS_T$$
$$= -10 \log \frac{1}{2} SS_T$$
$$= -10 \log \frac{1}{2} 30^2 + 35^2$$
$$= -10 \log \frac{1}{2} 900 + 1.225$$
$$= -10 \log \frac{1}{2} 2.125$$
$$= -10 \log 1.062,5$$
$$= -30,263$$

Table4.2S / N ratio calculation results

Trial	1	2	3	Y1	Y2	*Ratio S/N*
	A	B	C	I	II	
1	1	1	1	30	35	-30,263
2	1	2	2	35	38	-31,253
3	2	1	2	40	41	-32,149
4	2	2	1	50	51	-34,066
Total				155	165	

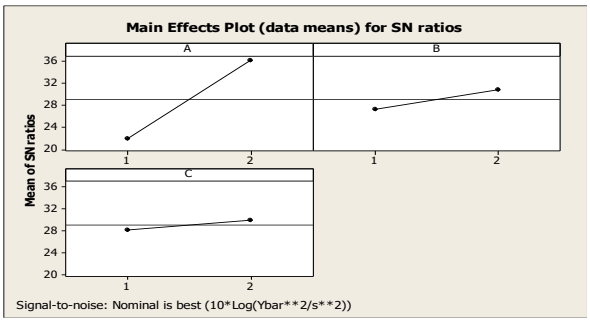

Figure 3.2 Main effects plot (data means) for SN ratios

V. RESULT AND DISCUSSION

A. Optimal Setting Level Analysis

The research was conducted in conditions where the factors that influence the quality are set at optimum conditions (the best level) so that in this condition, it is expected that the response (quality of production) is right from the experimental results at the best level quality loss will be determined here compared to the quality loss in the production of the first part so that the cost of losses can be determined if the production process is not set at the best level.

Table5.1Experiment Conditions in the second part

Factor	Influence factor	Initial conditions	Optimum condition
1	Pneumatic pressure	5 Kg	5 Kg
2	Tank wind pressure	3,5 KG	3,5 Kg
3	Dryer temperature	30˚C	27˚C

Tabel 5.2Second Trial Result

No. Trial	Initial conditions	Optimal Conditions
	Seat bear	*Seat bear*
	Jml	Jml
1	30	25
2	35	30
3	40	35
4	50	40
Average	38,75	32,5
Santard variance	72,91	41,66

B. Calculation of Optimal Conditions

The combination of factors under optimum conditions is A1, B2, C1, and quality losses for each quality characteristic shown in table 4.2.

The calculation of quality for each feature is
Specification of a bear seat <10.
Measurement results $\bar{y}$ = 32,5
A_0=Rp. 135.000 → estimated tire price
Constants (k) = $\frac{A_0}{\Delta^2}$ = $\frac{135.000}{10^2}$ = 1350

L(y) = k ($S^2 + y^2$)
= 1350 ($32{,}5^2$ + $41{,}66^2$)
= 1350 (1.056,25 +1.735,55)
= 1350 (2.791,8)
= 3.768.930

VI. CONCLUSIONS

Conclusions that can be drawn from the results of this study based on the results of the discussion and analysis carried out to achieve the research objectives are as follows:

1. Factors that significantly affect the defects resulting from the spraying process are:
   - Factor A is pneumatic wind pressure
   - Factor B is tank wind pressure
   - Factor C is the temperature of the dryer.
2. The optimal conditions of the influential factors in the spraying machine are as follows:
   - Factor A is pneumatic wind pressure: 5 Kg
   - Factor B is tank wind pressure: 3.5 Kg
   - Factor C is the dryer temperature: 27 ° C3.
3. The loss function in the initial conditions gave a loss of IDR 4.335.410 in the spraying machine process. After the optimal level set was obtained, a reduction in losses with optimal conditions of IDR 3.768.930, resulting in a decrease of IDR 566.480.

The motorcycle tire of the manufacturing industry is recommended to use the Taguchi method to reduce defects in the production process on each machine so that defects can be pressed in such a way and pressed as small as possible to zero defect.

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