Reducing Pouch Packaging Defects In Oil Products Using Taguchi Method At Salim Ivomas Pratama Ltd

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ABSTRACT: This research was conducted to determine what factors are very influential on the defects of pouch packaged cooking oil products and design the best input level with the result that can reduce defects of pouch packaged cooking oil. Actual data shows average of defects of pouch packaged during january to march 2018 produced as much 4,11 %. This research with experiment Taguchi method. Involve controlled and uncontrolled factors. The controlled factors is temperature heater sealing with 3 levels (126°C, 130°C, and 134°C), pressure air vaccum with 2 levels (5 bars and 6 bars), conveyor speed with 2 levels (900 rpm and 950 rpm), machine speed with 2 levels (35 rpm and 40 rpm), and packaging material with 2 levels (15 gr and 20 gr). With determination the level of each factor this research conducted 48 times with one-time iteration and data was taken by number of defects produced during the production process. The Result of analysis data shows that from above five factors controlled and interaction among five factors significant react to process produced cooking oil into pouch package. The best levels combination measure by smallest defects parameter that produced production process and statistic test (in particular S/N ratio) is temperature heater sealing 126 °C, pressure air vaccum 5 bars, conveyor speed 900 rpm, machine speed 35 rpm, and packaging material 15 gr can reduce defects with average from 4,11 % to 2,96 % (decrease about 1,15 %).

Index Terms: defects of package pouch, design by experiment, Taguchi method.

1 INTRODUCTION

One of the keys to success in winning industrial competition in the era of globalization is to pay attention to quality issues. This is because quality can influence the company's image and with good quality, the existence of the company can continue. Quality itself is the overall characteristics of a product or service that is able to provide satisfaction to customers or consumers [1]. The company engaged in agribusiness is Salim Ivomas Pratama Ltd, which is in Tanjung Priok, North Jakarta. At the plant, its activities include the production and sale of cooking oil, margarine, and palm-based vegetable fats. In the production division there are four departments tasked with producing product output, namely refineries, fractionation, bottling and margarine. However, the bottling department encountered problems in the form of product defects in the packaging. Where packaging defects can reduce the target to be achieved by the company. The results of brainstorming with supervisors found that the things that caused defects in the packaging were because there were interactions of several parameters such as temperature heater sealing, speed conveyor, vacuum wind pressure, packaging material and engine speed. To avoid packaging defects, companies need to make improvements and quality control in order to reduce the percentage of defects that occur during the production process. The following are data for cooking oil production defects from January to March 2018.

Tabel 1. Data on cooking oil production defects in January - March 2018

No	Bulan	Kemasan	Target Produksi (liter)	Kondisi Aktual (liter)	Jumlah Cacat (liter)	Total Cacat
1	Januari '18	Botol	9564	9192	372	2248
	Februari '18		22345	21455	890	
	Maret '18		25058	24072	986	
2	Januari '18	Jerigen	6527	6331	196	924
	Februari '18		15250	14770	480	
	Maret '18		7895	7647	248	
3	Januari '18	Pail	1150	1111	39	146
	Februari '18		1750	1688	62	
	Maret '18		1250	1205	45	
4	Januari '18	Pouch	16072	15422	650	2645
	Februari '18		21429	20544	885	
	Maret '18		26786	25676	1110	
5	Januari '18	Kaleng	650	635	15	23
	Februari '18		750	750	0	
	Maret '18		900	892	8	

From the table above it can be seen that there are still many defective products found in the production of packaged cooking oil. The biggest contributor is the cooking oil product packaged with a number of defects in the last three months 2645 liters. The packaging defect in the form of sealing is less sticky, as sloping / not precise, the body pouch is leaking where it allows the contamination of dust, dirt, and bacteria on cooking oil pouch. The formulation of the questions to be discussed in this study are:

1. What factors greatly affect the quality of pouch packaged cooking oil products?
2. How is the optimal input level treatment in some very critical parameters in the production process to reduce product defects that are produced?
3. Is the comparison of defective products during production before repair and after the repair is better or even the greater the number of defects?

The research objectives are as follows:

1. Determine the factors that influence the quality of the pouch cooking oil product.
2. Determine the optimum input level treatment in some very critical parameters in the production process to reduce the defects of the products produced.

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3. Know the comparison of defective products during production before repairs and after the repair is better or even the greater the number of defects.

LITERATURE STUDY

Definition of Quality
Quality is one of the important indicators for companies to be able to exist in the midst of intense competition in the industry. Quality is defined as the totality of the characteristics of a product that supports its ability to satisfy needs that are specified or specified. According to Crosby [2] Quality is conformance to requirement, which is in accordance with what is required or standardized. A product has quality if it is in accordance with predetermined quality standards. Quality standards include raw materials, production processes and finished products.

Quality Management
Basically Quality Management or Total Quality Management (TQM) is defined as a way to continuously improve performance (continuous performance improvement) at each level of operation or process, in each functional area of an organization by using all available human and capital resources. ISO 8402 (Quality Vocabulary) defines Quality Management as all activities of the overall management function that determine quality policy, goals and responsibilities, and implement them through tools such as quality planning, quality control, quality assurance, and quality improvement. Responsibility for quality management is at all levels of management, but must be controlled by top management (top management) and its implementation must involve all members of the organization. From the definition of quality management above, ISO 8402 (Quality Vocabulary) also presents several definitions of quality planning, quality control, quality assurance, and quality improvement (quality improvement), as follows [3]:

1. Quality planning is the establishment and development of goals and needs for quality and the implementation of a quality system.
2. Quality control is the techniques and operational activities used to meet quality requirements.
3. Quality assurance is all planned and systematic actions that are implemented and demonstrated to provide sufficient trust that the product will satisfy the needs for certain qualities.
4. Quality improvement is actions taken to increase product value for customers through increasing the effectiveness and efficiency of processes and activities through the organizational structure.

Metode Taguchi
The Taguchi method is a structured approach to determine the best combination in producing products in the form of goods or services. This method develops a methodology with a DOE based approach (Design Of Experiment). A method for identifying according to the number of input (input) is correct and the parameters for making a high-quality product in accordance with the wishes of customers or consumers. Genichi Taguchi developed a design approach from a robust design perspective, where products must be made free of defects and high quality. The Taguchi method is one of the philosophies and principles of experimental design invented by a Japanese engineer named Genichi Taguchi. Genichi Taguchi has an idea about quality engineering where the quality design goals are applied to every product and process that is related. Quality is measured based on the deviation from the characteristics of the target value [4].

Steps to implement the Taguchi method
1. Determination of non-independent variables
   Non-independent variables are variables whose changes depend on other variables. In planning an experiment must be chosen and clearly determined which non-independent variables are investigated.
2. Identification of factors (independent variables)
   Free variables (factors) are variables whose changes do not depend on other variables. At this stage the factors that will be investigated for its influence on the non-independent variable in question are identified.
3. Separator of control factors and disturbance factors
   The factors observed were divided into control factors and disturbance factors. In the Taguchi method both need to be clearly identified because the influence between the two factors is different.
4. Determination of the number of level and value level factors
   Selection of the number of important levels means for the accuracy of the experimental results and the cost of conducting the experiment. The more levels studied, the experimental results will be more thorough because there are more. But the number of levels will increase the number of observations so that the cost of the experiment increases.
5. Identify the interaction of control factors
   Interaction arises when two or more factors that experience recognition simultaneously will produce different results on quality characteristics when compared to factors that are treated individually [5].
   Errors in determining interactions will affect data interpretation errors and failures in determining the optimal process. But Taguchi is more concerned with observing the main causes so that the interaction is kept to a minimum, but it is not eliminated so it is necessary to study the possibility of the presence of interactions [5].
6. Calculation of degrees of freedom
   The degree of freedom is a concept that describes how much the experiment must be done and how much information is obtained from the experiment. For general equations of the degrees of freedom of the orthogonal array (Vvoa), in determining the number of experiments to be observed
7. Selection of orthogonal arrays
   In the Orthogonal Array selection must be suitable or suitable, it takes an equation from the orthogonal matrix which presents the number of factors, the number of levels and the number of observations to be made.
8. Assignment to factors and their interactions in orthogonal arrays
   Assignment of factors both control factors and disturbances and their interactions in selected orthogonal arrays by paying attention to:
   1. Linear Graph
   2. Triangular graphics

Both of these are factor assignment tools designed by Taguchi. Linear graphics identify various columns where factors can be assigned and the next column evaluates the interactions of these factors. Triangular table contains all possible relationships between factors (columns) in an OA [6].

9. Preparation and execution of experiments
   Experimental preparation included determining the number of replications and randomizing the experiment.
10. Analysis and interpretation of experimental results
   In this Taguchi method, data can be calculated and tested to obtain a condition where the results of the process achieve optimum conditions in the calculation, it can be seen how much each factor contributes.

Result and Discussion

Below is a data on the actual conditions of the production of packaged cooking oil pouch for 3 periods, namely in January, February and March 2018 obtained from company data

Table 1. Total Production and Actual Conditions for Defective Cooking Oil Packaging pouch

Bulan	Target Produksi (liter)	Kondisi Aktual (liter)	Jumlah Cacat (liter)	% Cacat
Januari '18	16072	15422	650	4.04%
Februari '18	21429	20544	885	4.13%
Maret '18	26786	25676	1110	4.14%
TOTAL	**64287**	**61642**	**2645**	**4.11%**

Average percent of total actual condition defects:

$$\bar{x} = \frac{\Sigma\ \text{Cacat}}{\Sigma\ \text{Target Produksi}}$$

$$= \frac{2645}{64287}$$

$$= 4.11\%$$

Formulation of the problem

The products produced by the company are cooking oil and packaged in various packaging, such as bottled bottles, jerry cans, pails, pouches and cans. The packaging material is obtained from suppliers and the bottling department is tasked with filling cooking oil products into various packaging. The next discussion focused more on cooking oil products with packaging pouch with filling process using handok machines. This selection is based on the number of defects greater than the other packaging. In the last 3 months, the number of defects in bottle packaging was 2248 liters, jerry cans of 924 liters, pail packaging of 146 liters, packaging pouches of 2645 liters, and cans of 23 liters.

Experiment Objectives

The objective to be achieved in this study is to determine the factors that influence the quality of packaging pouch cooking oil products, as a basis for taking experimental data. Determining the optimal setting level for some very critical parameters in the production process is needed to reduce defects in packaged cooking oil products. And, to know the comparison of defective products during the repairs and after the repairs there is a decrease or even a large amount of defects in the packaging products of pouch cooking oil.

Attribute Quality Measurement

1. Sealing is less sticky
2. Sealing sideways
3. The body pouch is leaking
4. The bottom pouch is leaking

Determination of Influential Factors

From the results of observations and brainstorming carried out there are 2 factors that affect the defect, namely technical factors and non-technical factors. This technical factor is very influential on the defects that occur, but this technical factor can be controlled such as:

- Temperature Heater Sealing (° C)
- Speed Conveyor (rpm)
- Air Pressure Vacuum (bar)
- Pouch (gr) packaging material
- Engine Speed (rpm)

There are interactions of the five technical factors that cause defects in cooking oil in pouch packages. For example, the interaction between temperature heater sealing to packaging material, if set at high temperature will damage the packaging material. Non-technical factors are factors that cannot be controlled but there are influences, although not large. These factors are:

- Operator
- Temperature of the production room
- Engine damage
- Power outage

However, these non-technical factors will not be discussed in this study.

Determination of Treatment Level for each Factor

To be able to carry out experiments, it is necessary to arrange the levels of controlled factors. This level of treatment or level is determined based on company records and engine capability limits. The tolerance limit set is 2% to 3% of the standard value commonly used by companies. Determining the level for each controlled factor for this experiment is as follows:

Table 2. Determination of the Level of each Factor

Faktor	Level		
	1	2	3
Temperature Heater Sealing (°C)	126	130	134
Pressure Angin Vakum (bar)	5	6	
Speed Conveyor (rpm)	900	950	
Speed Mesin (rpm)	40	35	
Material Kemasan (gram)	15	20	

Experimental Testing Data

By using 3 levels for 1 factor and 2 levels for 4 factors, the number of experiments conducted was 31 x 24 = 48 experiments with repetitions of one time. Complete data can be seen in table 3.

3. Experimental Data

Eks	Temperature (°C)	Pressure Vakum (bar)	Speed Conveyor (rpm)	Speed Mesin (rpm)	Material Kemasan (gr)	Jenis Cacat				Total	Σ
						1	2	3	4		
1	126	5	900	40	20	12	3	1	2	**18**	**32**
						10	3	0	1	**14**	
2	126	6	900	40	20	10	2	0	1	**13**	**25**
						8	3	1	0	**12**	
3	126	5	900	40	15	7	5	2	2	**16**	**28**
						8	3	0	1	**12**	
4	126	6	900	40	15	12	4	6	1	**23**	**49**
						15	2	7	2	**26**	
5	126	5	900	35	20	9	3	3	1	**16**	**28**
						10	1	1	0	**12**	
6	126	6	900	35	20	11	2	2	3	**18**	**32**
						10	1	1	2	**14**	
7	126	5	900	35	15	8	2	1	2	**13**	**20**
						6	0	0	1	**7**	
8	126	6	900	35	15	16	4	2	0	**22**	**47**
						18	6	0	1	**25**	
9	126	5	950	40	20	9	7	3	2	**21**	**35**
						6	5	1	2	**14**	
10	126	6	950	40	20	5	3	4	3	**15**	**25**
						2	1	6	1	**10**	
11	126	5	950	40	15	3	2	3	2	**10**	**15**
						1	0	4	0	**5**	
12	126	6	950	40	15	5	6	2	1	**14**	**29**
						3	7	3	2	**15**	
13	126	5	950	35	20	7	4	2	3	**16**	**30**
						6	3	2	3	**14**	
14	126	6	950	35	20	4	2	1	3	**10**	**20**
						3	1	2	4	**10**	
15	126	5	950	35	15	17	1	0	5	**23**	**48**
						15	0	4	6	**25**	
16	126	6	950	35	15	10	2	6	1	**19**	**37**
						8	0	7	3	**18**	
17	130	5	900	40	20	6	3	5	2	**16**	**29**
						7	1	3	2	**13**	
18	130	6	900	40	20	8	4	1	1	**14**	**26**
						5	6	1	0	**12**	
19	130	5	900	40	15	8	4	2	4	**18**	**34**
						5	6	2	3	**16**	
20	130	6	900	40	15	6	5	2	4	**17**	**32**
						4	4	3	4	**15**	
21	130	5	900	35	20	8	3	2	2	**15**	**22**
						2	2	1	2	**7**	
22	130	6	900	35	20	6	2	0	1	**9**	**20**
						7	0	2	2	**11**	
23	130	5	900	35	15	9	0	0	2	**11**	**22**
						8	1	1	1	**11**	
24	130	6	900	35	15	12	8	1	0	**21**	**42**
						10	7	3	1	**21**	

Table 3. Experimental Data (Cont)

Eks	Temperature (°C)	Pressure Vakum (bar)	Speed Conveyor (rpm)	Speed Mesin (rpm)	Material Kemasan (gr)	Jenis Cacat				Total	Σ
						1	2	3	4		
25	130	5	950	40	20	14	0	2	1	**17**	**36**
						15	1	1	2	**19**	
26	130	6	950	40	20	10	5	1	1	**17**	**35**
						9	6	1	2	**18**	
27	130	5	950	40	15	4	4	2	1	**11**	**21**
						2	3	3	2	**10**	
28	130	6	950	40	15	9	2	1	1	**13**	**21**
						7	0	0	1	**8**	
29	130	5	950	35	20	8	1	2	2	**13**	**23**
						6	1	1	2	**10**	
30	130	6	950	35	20	5	2	4	3	**14**	**31**
						7	3	3	4	**17**	
31	130	5	950	35	15	8	6	4	3	**21**	**40**
						7	5	4	3	**19**	
32	130	6	950	35	15	4	6	0	4	**14**	**28**
						5	5	0	4	**14**	
33	134	5	900	40	20	3	2	1	3	**9**	**15**
						2	0	1	3	**6**	
34	134	6	900	40	20	2	1	2	2	**7**	**13**
						2	2	1	1	**6**	
35	134	5	900	40	15	1	3	4	2	**10**	**17**
						0	2	3	2	**7**	
36	134	6	900	40	15	4	1	1	1	**7**	**11**
						2	0	2	0	**4**	
37	134	5	900	35	20	3	0	2	1	**6**	**12**
						4	0	1	1	**6**	
38	134	6	900	35	20	5	4	2	2	**13**	**23**
						5	3	1	1	**10**	
39	134	5	900	35	15	2	2	3	3	**10**	**17**
						1	2	2	2	**7**	
40	134	6	900	35	15	3	2	1	3	**9**	**19**
						4	1	3	2	**10**	
41	134	5	950	40	20	14	5	4	4	**27**	**52**
						12	4	4	5	**25**	
42	134	6	950	40	20	15	3	3	1	**22**	**41**
						12	2	3	2	**19**	
43	134	5	950	40	15	11	1	2	2	**16**	**30**
						9	1	1	3	**14**	
44	134	6	950	40	15	8	2	0	0	**10**	**25**
						11	1	2	1	**15**	
45	134	5	950	35	20	14	2	1	4	**21**	**36**
						12	1	0	2	**15**	
46	134	6	950	35	20	9	1	1	3	**14**	**27**
						7	0	2	4	**13**	
47	134	5	950	35	15	5	1	0	2	**8**	**17**
						4	0	2	3	**9**	
48	134	6	950	35	15	3	3	1	4	**11**	**18**
						0	2	2	3	**7**	

Testing the Normal Distribution of Experimental Data

From the results of observations using SPSS 22.0 for windows for normality testing the following results are obtained:
Hypothesis Testing Normal Distribution:
H0: the number of defects produced is normally distributed
H1: the number of defects produced is not normally distributed
Decision-making :
If the probability is> 0.1 then H0 is accepted
If the probability is <0.1 then H0 is rejected
Decision:

From the calculation of the Kolmogorov-Smirnov One-sample Test in attachment 1, the result of the asymp.ig (2-tailed) value is 0.200 and means that the probability of the price is above 0.1 so that the H0 decision is accepted and it is clear that the hypothesis is derived from normal distribution is acceptable.

Conclusion:

From the results of the above decision, it can be concluded that the number of defects produced (experimental data taken) is normally distributed.

Analyisis of Variance (ANOVA)

ANOVA calculations for several interactions between factors:

Sum of Squares Total :

$SSr = \Sigma\ (cacat)^2 - \frac{(\Sigma\ cacat)^2}{abcden} = 21217 - \frac{(1335)^2}{3x2x2x2x2x2} = 21217 - \frac{1782225}{96}$

$= 21217 – 18564{,}844$

$= 2652{,}156$

- Temperature Heater Sealing Factor

From table 4.3, the total number of defects can be calculated when temperature heater sealing 126 ° C, 130 ° C, and 134 ° C.
Σ defect for temperature heater sealing 126 °C = 500
Σ defect for temperature heater sealing 130 °C = 462
Σ defect for temperature heater sealing 134 °C = 373

$SS_{temperature} = \frac{1}{bcden} \sum_{i=1}^{a} cacat_i^{\ 2} - \frac{(\Sigma\ cacat)^2}{abcden}$

$SS_{temperature} = \frac{1}{2x2x2x2x2} [(500)^2 + (462)^2 + (373)^2] - \frac{(1335)^2}{96}$

$= \frac{1}{32} (602573) – 18564{,}844$

$= 265{,}562$

$df_{temperature} = 3 - 2$

$= 1$

$MS_{temperature} = SS_{temperature} / df_{temperature}$

$= 265{,}562 / 1$

$= 265{,}562$

$F_{temperature} = MS_{temperature} / MS_{E}$

$= 265{,}562 / 5{,}180$

$= 51{,}267$

• Vacuum Pressure Factor

From table 4.3, the total number of defects can be calculated when the vacuum pressure is 5 bars and 6 bars.
Σ defect for pressure vakum 5 bar = 659
Σ defect for pressure vakum 6 bar = 676

$SS_{pressure\ vakum} = \frac{1}{acden} \sum_{i=1}^{a} cacat_i^{\ 2} - \frac{(\Sigma\ cacat)^2}{abcden}$

$SS_{pressure\ vakum} = \frac{1}{3x2x2x2x2} [(659)^2 + (676)^2] - \frac{(1335)^2}{96}$

$= \frac{1}{48} (891257) - 18564{,}844$

$= 18567{,}854 - 18564{,}844$

= 3,010

$df_{pressure\ vakum}$ = 2 - 1
= 1

$MS_{pressure\ vakum} = SS_{pressure\ vakum} / df_{pressure\ vakum}$
= 3,010

$F_{pressure\ vakum} = MS_{pressure\ vakum} / MS_E$
= 3,010 / 5,180
= 0,581

• Speed Conveyor Factor

From table 4.3 can be calculated the number of overall defects when engine speed or engine speed 900 rpm and 950 rpm.

Σ defect for Speed Conveyor 900 rpm = 615
Σ defect for Speed Conveyor 950 rpm = 720

$$SS_{speed\ conveyor} = \frac{1}{abden} \sum_{i=1}^{a} cacat_i^2 - \frac{(\Sigma\ cacat)^2}{abcden}$$

$$SS_{speed\ conveyor} = \frac{1}{3x2x2x2x2}[(615)^2 + (720)^2] - \frac{(1335)^2}{96}$$

$= \frac{1}{48}$ (896625) - 18564,844
= 18679,688 - 18564,844
= 114,843

$df_{speed\ conveyor}$ = 2 - 1
= 1

$MS_{speed\ conveyor} = SS_{speed\ conveyor} / df_{speed\ conveyor}$
= 114,843

$F_{speed\ conveyor} = MS_{speed\ conveyor} / MS_E$
= 114,843 / 5,180
= 22,170

• Machine Speed Factor

From table 4.3 can be calculated the number of overall defects when engine speed or engine speed 40 rpm and 35 rpm.

Σ defect for Speed Machine 40 rpm = 676
Σ defect for Speed Machine 35 rpm = 659

$$SS_{speed\ machine} = \frac{1}{abcen} \sum_{i=1}^{a} cacat_i^2 - \frac{(\Sigma\ cacat)^2}{abcden}$$

$$SS_{speed\ machine} = \frac{1}{3x2x2x2x2}[(676)^2 + (659)^2] - \frac{(1335)^2}{96}$$

$= \frac{1}{48}$ (891257) - 18564,844
= 18567,854 - 18564,844
= 3,010

$df_{speed\ machine}$ = 2 - 1
= 1

$MS_{speed\ machine} = SS_{speed\ machine} / df_{speed\ machine}$
= 3,010

$F_{speed\ machine} = MS_{speed\ machine} / MS_E$
= 3,010 / 5,180
= 0,581

- Faktor Packaging material

From table 4.3, it can be calculated the total number of defects at the time of weight packaging material 15 grams and 20 grams.

Σ defect for packaging material 15 gram = 667
Σ defect for packaging material 20 gram = 668

$$SS_{packaging\ material} = \frac{1}{abcd} \sum_{i=1}^{a} cacat_i^2 - \frac{(\Sigma\ cacat)^2}{abcden}$$

$$SS_{packaging\ material} = \frac{1}{3x2x2x2x2}[(667)^2 + (668)^2] - \frac{(1335)^2}{96}$$

$= \frac{1}{48}$ (891113) - 18564,844
= 18564,854 - 18564,844
= 0,10

$df_{packaging\ material}$ = 2 - 1
= 1

$MS_{packaging\ material} = SS_{packaging\ material} / df_{packaging\ material}$
= 0,10

$F_{packaging\ material} = MS_{packaging\ material} / MS_E$
= 0,10 / 5,180
= 0,019

• Conveyor - engine interactions

From table 4.3 can be calculated the total number of defects when the conveyor speed (900 rpm and 950 rpm) interacts with engine speed (35 rpm and 40 rpm) which can be seen in table 4.5.

Table 4.5 Interaksi conveyor – machine

Speed Conveyor	Speed Mesin	
	40	35
900	311	304
950	365	355

$$SS_{conveyor\ -\ machine} = \frac{1}{aben} \sum_{k=1}^{c} cacat_{ij}^2 - \frac{(\Sigma\ cacat)^2}{abcden} - SS_{conveyor} - SS_{machine}$$

$$SS_{conveyor\ -\ machine} = \frac{1}{3x2x2x2}[(311)^2 + (304)^2 + (365)^2 + (355)^2] - \frac{(1335)^2}{96} - 295,60 - 3,16$$

$= \frac{1}{24}$ (448387) – (18564,84 - 295,60 - 3,16)
= 416,71

$df_{conveyor\ -\ machine}$ = (2 – 1) (2-1)
= 1

$MS_{conveyor\ -\ machine} = SS_{conveyor\ -\ machine} / df_{conveyor\ -\ machine}$
= 416,71

$F_{conveyor\ -\ machine} = MS_{conveyor\ -\ machine} / MS_E$
= 416,71 / 5,180
= 80,445

Percent Contribution

After knowing the factors and interactions between factors that have a significant effect on the occurrence of defects, it is necessary to calculate how much influence it has. From the ANOVA table it is known:

MS_E = 4,500
SS_r = 23356,156

These two values are used to calculate the following percent of contributions:

Temperature heater sealing

$SS'_{Temperature} = SS_{Temperature} - (MS_E \times df_{Temperature})$
= 259,738 – (5,180 x 2) = 249,378

$P = \frac{SSTemperature}{SSr} \times 100\ \% = \frac{249,378}{2652,156} \times 100\ \% = 9,40\ \%$

- Temperature – Packaging material

$SS'_{Temperature-packaging\ material} = SS_{Temperature-packaging\ material} - (MS_E \times df_{Temperature-packaging\ material})$
= 219,047 – (5,180 x 2) = 209,011

$P = \frac{SS'Temperature-speed\ machine}{SSr} \times 100\ \% = \frac{209,011}{2652,156} \times 100\ \% = 7,88\ \%$

Complete calculation of percent contribution can be seen in table 4.9.

Tablel 4.9 Calculation of Percent Contribution

Faktor atau Interaksi Faktor (i)	SSi	df	SS'i	P (%)
Temperatur heater sealing	259.738	2	249.378	9.40
Pressure angin vakum	110.827	1	100.467	3.79
Speed conveyor	294.525	1	284.165	10.71
Speed mesin	798.407	1	788.047	29.71
Material kemasan	1450.071	1	1439.711	54.28
Temperatur heater sealing* Material kemasan	219.047	2	209.011	7.88
Speed mesin*Material kemasan	86.092	1	75.732	2.86

From table 4.9 above, it can be seen that the factors that make a large contribution to the occurrence of defects are packaging material, which is equal to 54.28%. While the three factors and the other two interactions have a low contribution to product variation. Because the packaging material factor has the largest percent contribution even greater than 50%, this means that the packaging material factor used must be controlled properly.

Signal to Noise Ratio

Signal to Noise Ratio (S / N) is needed to determine the effect of noise factors on product quality. The S / N ratio takes into account the variation of the product produced. The calculation of the S / N ratio for this study is based on the situation smaller is better because the experimental response used is the number of defects for each type of defect (the less the better).

For Experiment 1:

From table 4.3 obtained:

The number of looping defects 1 = 18

Number of looping defects 2 = 14

S/N = - 10log 10 ($\frac{18^2+14^2}{2}$) = - 10 log (260) = - 24,150

For Experiment 2

From table 4.3 obtained:

The number of looping defects 1 = 13

Number of looping defects 2 = 12

S/N = - 10log 10 ($\frac{13^2+12^2}{2}$) = - 10 log (156,5) = - 21,945

The optimum level for each factor is based on the S / N ratio (the smallest absolute value or close to zero value) in this case for the temperature heater factor sealing is chosen with its S / N ratio with a large absolute value because the tendency of the graph results decreases (negative). Then, the optimum level parameter settings are as follows:

1. Temperature heater sealing: 126 ° C
2. Pressure vacuum air: 5 bars
3. Speed conveyor: 900 rpm
4. Engine speed: 35 rpm
5. Packaging material: 15 gr

Advanced Experiments

This advanced experiment uses parameters that have been obtained from observations and research. Applied to the production process and the results are compared with the results of the production process before the experiment is carried out. The result in question is the ratio of the number of defects to the total production. The total production and number of defects before and after the experiment can be seen in tables 4.1 and 4.10

Table 4.10 Total Production and Defects of Pouch Cooking Oil Packaging After Experiments

Bulan	Σ Produksi (ltr)	Σ Cacat (ltr)	% Cacat
Juni '18	25500	755	2.96%

Percentage of defect $= \frac{\Sigma \text{ Cacat}}{\Sigma \text{ Produksi}}$ x 100%

$= \frac{755}{25500}$ x 100%

= 2,96 %

Decreased average percent defects

= %defect before exp. - % defect after exp

= 4,11 % - 2,96%

= 1,15%

From the results of calculations, the mean defect value after the experiment is smaller than before the experiment, which means that the production process after this experiment has increased in quality because the number of defects dropped.

CONCLUSION

Here are some conclusions from this study that will answer the purpose of this study.

1. The biggest factor affecting the quality of packaged cooking oil pouch is the weight of packaging material with the largest percentage percent contribution of 54.28%.
2. The level of treatment or level of each controlled factor is as follows:
   - Temperature heater sealing = 126 ° C
   - Vacuum wind pressure = 5 bars
   - Speed conveyor = 900 rpm
   - Engine speed = 35 rpm
   - Packaging material = 15 gr

The application of the best process parameters obtained from experimental results using the Taguchi method can reduce packaging defects that occur. This is evidenced by the decline in the average defect rate from 4.11% to 2.96% (there was a decrease in defects of 1.15%).

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