QUALITY IMPROVEMENT STRATEGY ON CRISPY CREAM PRODUCT PROCEES WITH TAGUCHI METHOD APPROACH

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ABSTRACT

This paper is an explanation of Taguchi Methods. Taguchi methods was known for a long time and used in many fields by experts and engineers. Taguchi methods were used in some fields. Using of Taguchi methods in quality improvement has already done too, like design product. This paper explains the application of Taguchi methods in analyzing the level of powder sugar smooth Crispy Cream in order to be mixing goods of bar chocolates. The application results of Taguchi method indicate that the influencing factors are machine vibrate, extracting time, sugar volume and machine lid by using plastics. It is also figure out the determining of a good level, i.e. on the vibration of machine applying level 2 (90 Rpm), the time of extracting is on level 2 (100 grams) and the machine lid is on level 1 (by using plastics)
Key word : Taguchi methods, quality improvement, Crispy Cream

1. INTRODUCTION

1.1. Background

A quality product can be produced through research by the R & D, good production process, and control every production process. To obtain a good quality production, it is necessary to do the measurement setting the optimal production process. One of the efforts in improving the quality of the production process is through the design of experiments. Many experimental designs have been developed by experts, including the Taguchi method. Taguchi method of background comes from Sir Ronald Fisher in the 1920s, which has developed the technique of experimental design for research. Taguchi method is a method of solving problems with statistical parametric approach because it is assumed that the data used is normal distribution. As a manufacturing company that produces various kinds of chocolate, the production management of PT. XYZ working continuously to improve its production processes to produce quality product.

1.2. Problem Identification

The resulting chocolate product PT. XYZ requires raw materials as a food sweetener. Raw materials used as food sweetener is sugar. The sugar was used in chocolate products are sugar crispy cream. In order to rapidly dissolve the sugar at the time of mixing and stirring process the raw materials, the sugar that is used must have a high level of refinement. For that, companies need to examine the subtleties of sugar that will be used by using vibrating machines. By using this machine, we can determine if the sugar is refined and can be produced or not.

1.3. Objective Research

1. Identifying the factors that most affect the quality characteristics of sugar sifting crispy cream.
2. Determining the optimal settings for these factors, which it can produce a minimum of sugar remaining.

1.4. Research Scope

This research is limited in the case of sifting process of Crispy Cream sugar with vibrating machines. This machine is used to measure the smoothness of the shape of the material by sifting flour in a sieve that has a certain size, weight, time, vibration, and cover the specified operator. Determined was by the settings of sifting a sieve with a mesh 100 and mesh 200. The problem that occurs is how to manage weight, time, vibration, and a good cover on the engine and the optimal order to minimize the remaining sugar crispy cream that has been sifted using a vibrating machine for faster production process done.

2. LITERATURE REVIEW

2.1. Quality Engineering

Engineering openly quality is an activity to observe and control the quality at each production process directly. This activity is very important in keeping the production costs are low and can also directly improve the quality of the product. Engineering openly quality can also control the production machines that can prevent damage to machinery production. Some of the models used in engineering openly quality is :

1. Statistical process control is observing, controlling and testing at each stage of production to avoid significant deviations;
2. Static signal-to-noise is reducing the variation by using the application of force to solve design problems in the production process.
3. Compensation of control plans to keep the process going as targeted.
4. Loss Function-Based Process Control is the reduction of all production costs including the cost per unit, inspection fees, and expenses set-up is needed in process control and quality losses caused by remaining variation in the output.

Many ways that can be used to improve the quality of a product. One of the most common ways used to solve quality problems is to directly control the parameters that affect the quality of experimental design methods. The purpose of the implementation of experimental design is to obtain the optimal parameter settings of a certain quality characteristics through the implementation of a structured experiment. One of the method that can be used to improve the quality of the Taguchi method. In the ISO 8402 quality as the totality of characteristics defined a product that supports its ability to satisfy specified requirements. Quality is often defined as customer satisfaction or confirmation of the needs or requirements. Although there is no sense of quality that is universally accepted, from the definitions above it there can be seen that there are some similarities in the definition of quality in the element as a follows :

1. Involves the quality meet or exceed customer expectations.
2. Quality includes products, services, processes and environment.
3. Quality is an ever-changing the conditions.

With based on these elements, Goetsch and Davis make a definition of quality broader scope, namely: "Quality is a dynamic state associated with products, services, people, processes and environments that meet and exceed expectations”

2.2. Taguchi Method

This method was coined by Dr. Genichi Taguchi in 1949 when he was given the task of improving communication systems in Japan. He has a technical background, also deepen knowledge of statistics and engineering. This method was found to meet the information accurate at the time of the experiments were not possible. Taguchi method begins with a classic experiment design method developed by RA Fisher in the United Kingdom, this method based on statistical approach based on the Latin square and was originally developed for the agricultural industry. This method becomes impractical to apply to the manufacturing industry because of certain assumptions and emphasis on certain procedures. Taguchi experimental design method was developed by utilizing the nature of robust design. Since 1960, Taguchi method has been successfully used to improve the quality of Japanese products. In 1980, many companies are finally realizing that the old methods no longer competitive and to ensure the quality of the product for inspection can be improved the quality of the product defects. However, according to Taguchi, the quality of the product should be considered from the beginning, is starting from the product design stage. Dr. Genichi Taguchi as the originator and the Taguchi method, the 3 suggests a simple and fundamental concept, namely :

1. Quality must be design into the product, so that priority is not having an inspection but the increase in quality.
2. Achieving the best quality is to minimize the deviation of the product from a target value. Products must be designed so that is not affected by environmental factors that are not controlled.
3. Ordinary quality should be measured based on the function of the deviation from the standard value and losses are measured as a whole.

Taguchi concept is made from research W.E. Deming which states that 85% of poor quality due to the manufacturing process and only 15% of the workers. Then he developed a manufacturing system is "strong" or not sensitive to the daily and seasonal variations of the environment, machinery, and external factors others. Basic Taguchi methods comes from the following premise 2 :

1. Products that do not reach the target will give harm to the community.
2. Product design and development process requires a systematic and progressively steps through the system design, design parameters, and finally the design tolerance.

Orthogonal Array (OA) is one part of the experimental group who only use part of the state total, where this section perhaps only half, quarter or an eighth of a full factorial experiment. OA was created by Jacques Hardmard in 1897, and began to be applied during World War II by Placket and Barman. Taguchi matrix are mathematically identical to the matrix Hardmard, only the columns and rows do settings again. OA advantage is the ability to evaluate how factors with a minimum number of tests. Which of the experiments are 7 factors with 2 levels, so if using a full factorial will need 128 pieces of the experiment. With OA, the number of experiments that need to be done can be reduced and only 8 experiments that will reduce the time and cost of the experiment. OA has been providing various combinations of OA to the test matrix with factor 2 and 3 levels with the possibility for multiple levels of testing.

3. RESEARCH METHODOLOGY

3.1. Thought Framework

This paper used the example of existing problems in the PT. XYZ, brand namely producing chocolate. As one of the problems was faced by these companies is crispy sugar screening process in order to minimize the cream remaining sugar that is not filtered. With the level of high sugar refinement, then the production process can be more quickly implemented. Therefore, we focus on the writing of this paper is only on the proposed improvement of the setting of sifting the sugar by using a vibrator machine. The improvements made of the setting time and the vibration would be required for sugar can be filtered out or not remains perfect.

3.2. Type and Source of Data

Types of data was used consists of primary data and secondary data. Primary data obtained from field survey and in-depth interviews with various parties. Conducted was the field survey data to determine the characteristics of quality, determining the number of levels and level values of factors.

3.3. Technical Analysis

Determining the level of quality is done by using the Taguchi method. This method is useful in designing products in accordance with the desired settings for optimal predetermined executable.

4. RESULT AND DISCUSSION

4.1. Cases Study

From the results of discussions and interviews that have been made known to the target value of the sifting process is 6 grams of sugar, where the sum is the lowest amount that can be achieved from the experiment that has been done so that disability is still under standardization, i.e. 12% of the total weight of sugars. For more details, the amount of the target value includes the amount of sugar that is not filtered due to take refined sugar that still clot. This minimum sought by the company because the consumer wants no lumps of sugar in the chocolate product blocks. Of the value of the target to be achieved, then the value is Smaller The better, that is, the smaller the number of failures or near zero, then the resulting product quality will improve. From the result of direct observations conducted authors, it can be known how the sugar screening process done.

Taguchi called level for each setting that will be used and this level is useful to determine the Orthogonal Array (OA) which will be done. Here is the value at a level that will be used for each control factor. This value is obtained from the specified level settings.

Table 4.1 Value Level Control Factors for Failure of sifting

Code	Control Factor	Unit	Level 1	Level 2
A	Vibration Machine	Rpm	95	90
B	Left sift Minute	Minute	15	20
C	Weight	Gram	100	90
D	Density	Plastic	Wear	Not to Wear

From the results of the selection factors and levels, there are 4 factors that are used and there are two interactions between factors. Further calculations carried out for the degrees of freedom that will be used. Degrees of freedom will determine the election on the calculation Taguchi OA. Each selected factors have 2 levels, then the degrees of freedom (D. o. F) for each factor is:

D. o. F for the factor A = n A - 1 = 2-1 = 1
D. o. F to factor B = n b - 1 = 2-1 = 1
D. o. F for the factor C = n C - 1 = 2-1 = 1
D. o. F to factor D = n D - 1 = 2-1 = 1
D. o. F for Factor A x B = (n A - 1) x (NB - 1) = (2 - 1) x (2 - 1) = 1
D. o. F to factor AXD = (n A - 1) x (n D - 1) = (2 - 1) x (2 - 1) = 1

The number of D. o. F :
total =(n A - 1)+(NB - 1)+(n C - 1)+(n D - 1)+ (n A x B - 1)+(n A x D - 1)
= 1 + 1 + 1 + 1 + 1 + 1 = 6

After receiving the results of the calculation of degrees of freedom for each factor, it can be seen that the failure of sifting has D. o. f at 6. Based on the value of the D. o. f, then determined that the type of OA used is L8 (27). OA elections must satisfy the equation:

$F_{IN} \geq$ f needed to factor and interaction
Number of Trial - 1 ≥ Total D. o. F
8 to 1 ≥ 6
7 ≥ 6

Equation is fulfilled, because there are 6 factors involved in the Taguchi experiment, the used L8 (27). The numbers of experiment were chosen based on the OA election tables that have been determined, listed in Table 4.2.

Table 4.2 Orthogonal Array Selection and Appropriate Number of D. o. F

TOTAL D. o. F	*Orthogonal Array*
2 – 3	L_4
4 – 7	L_8
8 – 11	L_{12}
12 – 15	L_{16}

Table 4.3 below is a table that is used by OA L8 appropriate degree of calculation and the calculation of OA Free.

Table 4.3 Orthogonal Array L8 (2^7)

Experiment	Number of column						
	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

After selecting the appropriate OA table, then the next can experiment as much as 8 times with the provisions of each experiment repeated 3 times to get better results. Here is a table 4.4, the results of an experiment that has done the author. So the total number of experiments conducted for each type of disability is a much of 24 times.

Table 4.4 Calculation Results of experiments for the failure of sifting

Experiment	No. sifting Column						Failure (%)		
	A	B	AxB	C	D	AxD	1	2	3
1	1	1	1	1	1	1	7.90	6.10	7.65
2	1	1	1	2	2	1	16.37	12.92	17.32
3	1	2	1	1	1	1	7.73	7.67	8.50
4	1	2	1	2	2	1	10.48	14.08	8.93
5	2	1	2	1	2	2	8.82	6.85	7.02
6	2	1	2	2	1	2	9.95	9.41	11.12
7	2	2	2	1	2	2	8.78	7.66	8.28
8	2	2	2	2	1	2	6.91	7.68	7.73

4.2. Discussion

Table 4.5 shows the results of the calculation for the average, deviations and Signal To Noise Ratio (SNR). SNR performed to determine the effect of each control factor and the interaction is between factors. The average is performed to determine the average failure happens sifting of each experiment using the OA table. Standard deviation is used to determine how much distortion that occurs on sifting process.

Table 4.5 Result Calculation Manual For Average, Deviation and SNR

Experience	No. Columns sifting						Failure (%)			Result (%)		
	A	B	AxB	C	D	AxD	1	2	3	Average (%)	S (%)	SNR (dB)
1	1	1	1	1	1	1	7.90	6.10	7.65	7.22	0.98	-17.22
2	1	1	1	2	2	1	16.37	12.92	17.32	15.47	2.24	-23.85
3	1	2	1	1	1	1	7.73	7.67	8.50	7.97	0.463	-18.03
4	1	2	1	2	2	1	10.48	14.08	8.93	11.16	3.76	-21.15
5	2	1	2	1	2	2	8.82	6.85	7.02	7.56	1.09	-17.63
6	2	1	2	2	1	2	9.95	9.41	11.12	10.16	1.24	-20.16
7	2	2	2	1	2	2	8.78	7.66	8.28	8.24	0.56	-18.33
8	2	2	2	2	1	2	6.91	7.68	7.73	7.4	0.65	-17.44
Average										9.4	1.37	-18.99

At the time factor and level selection for the sifting process, there are 4 factors that can be controlled and have each of the 2 level is then used to find the difference of each level in order to determined the best sequence of levels, which are shown in Table 4.6 - Table 4.8.

Table 4.6. Top Level Election Process to Sift Average

Factor	Average		Difference	Rank	Optimum
	Level 1	level 2			
A	9.82	7.91	1.91	2	A2
B	9.49	8.24	1.25	4	B2
C	7.36	10.37	3.01	1	C1
D	8.15	9.56	1.41	3	D1

Table 4.7. Best Level Selection Process for Diversion Sift / S

Factor	S (%)		Different (%)	Rank	Optimum
	Level 1	level 2			
A	1.86	0.89	0.97	3	A2
B	1.39	1.36	0.03	4	B2
C	0.77	1.97	1.2	1	C1
D	0.83	1.95	1.12	2	D1

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