Case study

REDUCTION OF DEFECT RATE IN BISCUIT PRODUCTION USING STATISTICAL QUALITY CONTROL PROCESS

ABSTRACT

In the manufacturing setting, quality improves reliability, increases productivity and customer consummation. Quality in manufacturing needs the practice of quality control. In this research work, the level of quality control in biscuit manufacturing / packing are investigates. The study involves inspection of some randomly selected finished products on daily bases. The main objective is the application of statistical quality control technique in production department by the help of lower control limit and upper control limit.

Keywords: Quality control, biscuit manufacturing, Statistical quality control

I. INTRODUCTION

A quality product is one whose inherent characteristics achieve consumer needs. It is the key to improving an enterprise's profitability. A successful business event, whether in manufacturing or services, cannot be separated from the consumer and the product. In today's information and technology-driven world, companies have to compete with consumers who are more sensitive to quality when choosing products or services. In order to meet this condition, the company must pay attention to the quality of its products and intensify its efforts to produce quality goods or services, so that the product can be accepted by consumers and be competitive with other products. All companies recognize quality is important, but each company views quality control in a different way [10].

So, the company's quality control is necessarily needed, by producing the customer's needs the company will attract consumers to buy the company's products in fulfilling their needs. So that from the consumer buying company can increase profits.

In a biscuit bakery, the Quality control functions will cover the following elements: (i) Specifications and quality of all raw materials including ingredients and packaging materials. (ii) Production and packaging equipment. (iii) Equipment maintenance. (iv) Process control throughout the industrial procedure.

All measures which are concerned with the quality control of the finished products should be carefully reviewed to maintain high standards. The completed product should be inspected for colour, texture, pellet size, strength, aroma, palatability, and chemical composition before delivery.

Many methods can be used to control the quality of each characteristic. Using Statistical Process Control (SPC) in quality control means quality is controlled from the beginning of the production process, during the production process until the finished products [5].

Through mathematical, there are several methods for quality control. Among one of the SPC tools is control chart and depend on one research say that it is not easy to successfully implement effective and sustainable control methods. The control chart is one usually used tool in the measure and control phase.

Here are some steps to develop a quality control are namely; Set your quality standards, Decide which quality standards to focus on, Create operational processes to deliver quality, Review your results, Get feedback, make improvements.

The variable of this research is quality control, in which the quality control problem is a problem that can't be measured directly and need detailed indicators to be measured clearly. Thus the problem of quality control is a hidden variable. A hidden variable is a formation variable or hidden variable that must be declared by using an indicator.

The population and the sample in this study is the number of biscuit packs during the six weeks from November to December 2021. Data used in this study consisted of secondary data about the number of production, product defect, and the number of samples [1, 2, and 3].

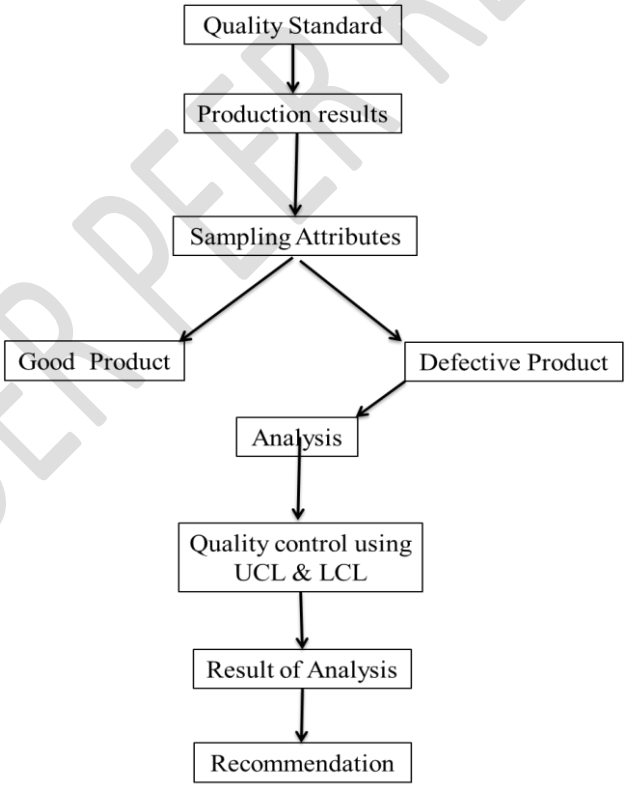

Figure 1: Flow chart for the Biscuit production process

At the beginning of this study, data were collected for each defect's type and frequency with the product, i.e., biscuit packets. These defects can be classified into two main categories, namely biscuit defects and packaging defects. These two categories of defects can be further broken down as follows:

Packaging defects: Underweight packages, overweight packages, off registration, met layers, sealing defects, pinholes, and loose packaging.

Biscuit defects: Cream oozing, hard bite, Breakage, blisters, shrinkage, biscuit spreading, and reverse shell. Here defective categories contain seven biscuit defects and seven packaging defects all [4].

II. DATA ANALYSIS AND METHODOLOGY

A. Data Collection

In the next step, the sampling of the product was done for six weeks. This allowed us to calculate the final product's rejection rate due to each type of defect, as shown in Table 1.

Table 1. *Data for defective biscuits Over Six Weeks (November-December) in 2021*

Type of defects	**Week I**	**Week II**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Total Defects**
Breakage	31	25	35	28	35	33	187
Blisters	16	20	20	21	20	22	119
Off Registration	14	10	13	7	11	12	67
Cream oozing	3	1	3	5	3	7	22
Hard bite	0	3	4	1	1	1	10
Pin Holes/ cuts	3	1	0	1	1	1	7
Shrinkage	2	0	1	1	2	1	7
Overweight packets	2	1	1	0	2	0	6
Met layer	1	0	3	0	1	1	6
Sealing defects	2	1	1	1	0	1	6
Underweight Packets	1	0	1	1	1	1	5
Loose packaging	0	1	1	2	0	1	5
Reverse shell	0	0	1	1	1	1	4
Biscuit spreading	1	1	0	0	2	0	4
Total Number of defects	76	64	84	69	80	82	455
Number of items inspected	725	725	725	725	725	725	
Total Production	58000	58000	58000	58000	58000	58000	

After the check sheet is done next step is to produce a graph. That graph is useful to get in which week are more defective biscuits [10].

B. Beget and Effect Diagram

An unproductive illustration or fishbone diagram was made to analyze the factors that become the cause of product defects. The factors that impact and beget imperfect products can generally be classified as : *Man*, *Material*, *Machine*, *Method*, *Environment*.

This illustration is a schematic tool used for graphically showing them to analytically classify implicit causes for a certain form of defect, signifying a cause-and-effect correlation between hypotheses. Although the cause-and-effect graphs display multiple variables that need to

be studied, the focus is on the most possible cause(s) that eventually leads to the rejection of the substance. A cause-and-effect illustration for the three major forms of defects from Table-I, has been prepared for this review, namely Breakage, Sores, and off registration [12].

Breakage: System misalignment, incorrect baking, lack of care, lack of ergonomic considerations, lack of operator expertise, improper handling of equipment are the crucial causes of breakage defects.

Blisters: Sluggish roller drive speed, high temperature, unnecessarily long baking process, lack of preventive maintenance are the major causes of blistering in the biscuits.

Off Registration: The root causes of off registration defects in the packaging process are poor gear conditions, malfunctioning web page, incorrect tolerances in measuring instruments, inadequate operator training.

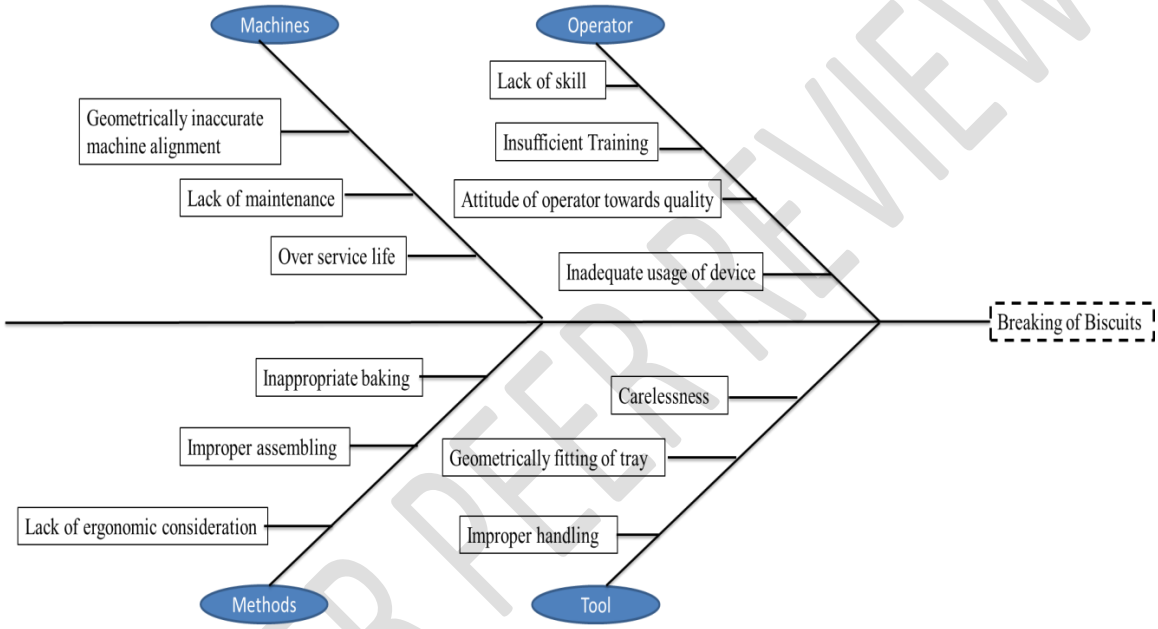

Figure 2: Beget and effect diagram for breakage defect

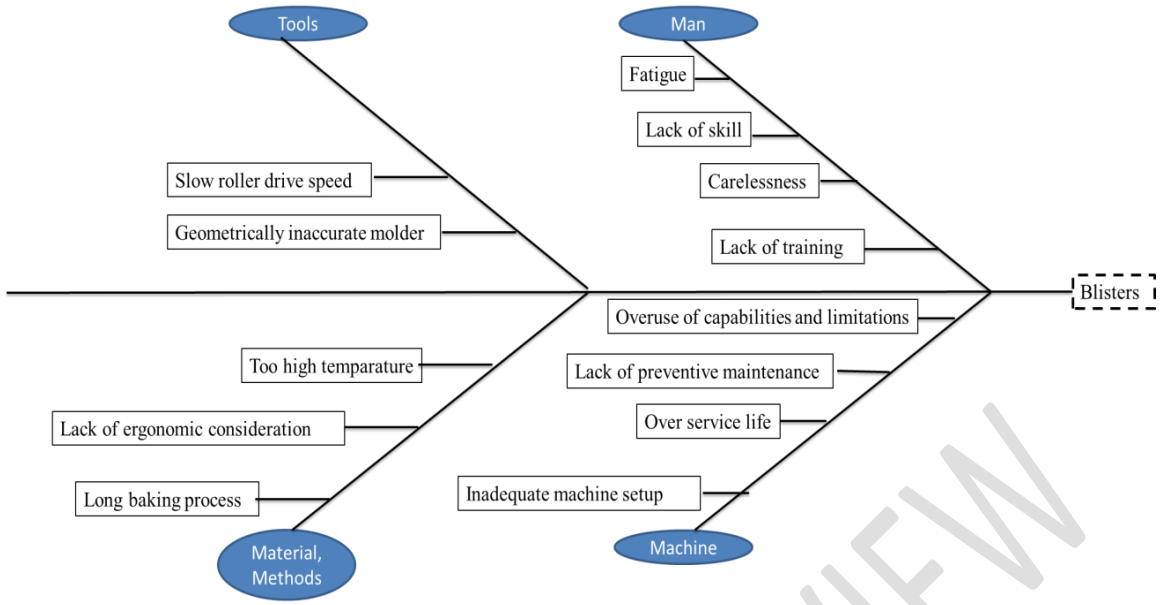

Figure 3: Beget and effect diagram for blistering defect

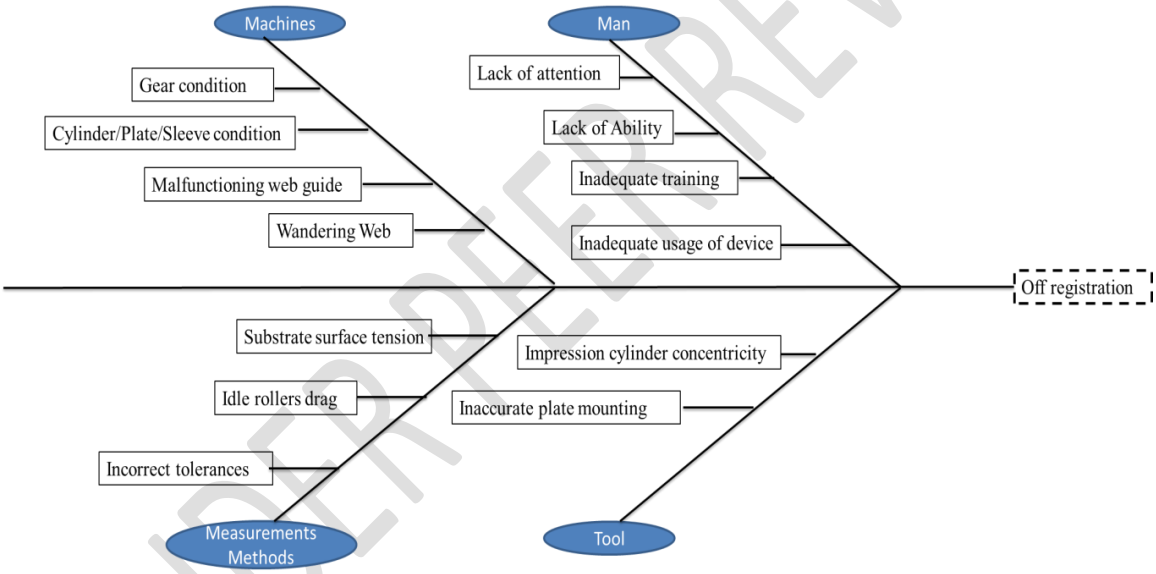

Figure 4: Beget and effect diagram for off registration defect

III RESULT AND DISCUSSION

Quality control of the finished product is done through the inspection. In general, the characteristics of good quality for biscuits, according to the ingredients in the machine setting.

The first step taken to analyze statistical quality control is to create a table (check sheet) the production quantities and product defects / incompatible with quality standards.

Table 2. *Percentage of defective Biscuit production during Six weeks (November-December) in 2021*

Duration (Weeks)	**Total no. of production**	**Number of items Inspected**	**Total no. of Defects**	**Defect %**

1	58000	725	76	10.4827
2	58000	725	64	8.82758
3	58000	725	84	11.5862
4	58000	725	69	9.5172
5	58000	725	80	11.0344
6	58000	725	82	11.3103
Total	348000	4350	455	10.4597
Average	58000	725	75.833	10.4597
%	3480	43.5	4.55	10.4597

The central line lies between the upper control limit (UCL) and lower control limit (LCL). The centerline is a line that represents the average defect rate in a production process. To calculate the center lines use the formula: $CL = \bar{p} = \frac{\sum np}{\sum n}$, where $\sum np$ denotes the total defects and $\sum n$ denotes the total information obtained [10].

Table 3. Total Number of Defects, Total Number Inspected, and Central Line (CL) for six weeks Biscuit production

Week's	**Total no. of production**	$\sum np$	$\sum n$	**Central line**
1	58000	76	725	0.1048
2	58000	64	725	0.0882
3	58000	84	725	0.11586
4	58000	69	725	0.09517
5	58000	80	725	0.11034
6	58000	82	725	0.1131

(i) Calculating Upper Control Limit (UCL)

To calculate upper control limit performed by the formula:

$$UCL = \bar{P} + 3\left(\sqrt{\frac{\bar{P}(1-\bar{P})}{N}}\right)$$

where $\bar{P}$ denotes product defects average / central line-and n is size of each sample

(ii) Calculating Lower Control Limit (LCL)

To calculate lower control limit performed by the formula:

$$LCL = \bar{P} - 3\left(\sqrt{\frac{\bar{P}(1-\bar{P})}{N}}\right)$$

where $\bar{P}$ denotes product defects average / central line-and n is size of each sample

From the calculation above we can make a chart using microsoft excel 2007 which can be seen in figure below.

Table 4: Lower and Upper control limit

Week	LCL	UCL
1	0.100985	0.108615
2	0.084667	0.091733
3	0.111873	0.119847
4	0.091515	0.098825
5	0.106437	0.114243
6	0.109155	0.117045

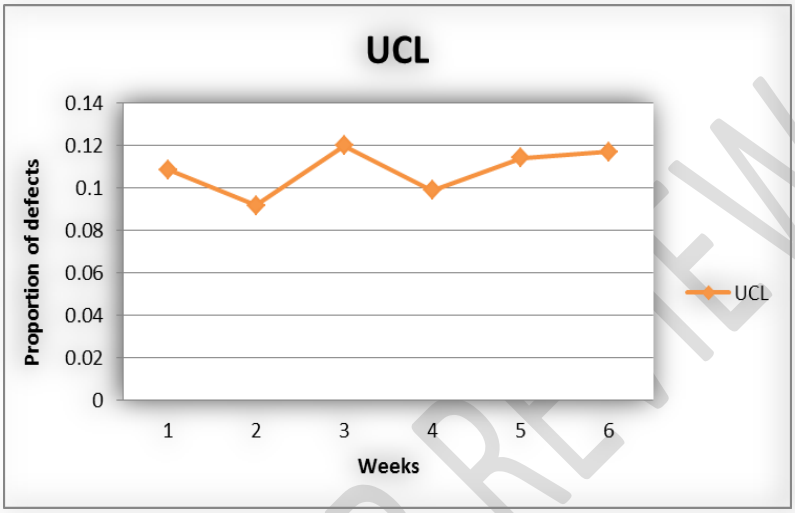

Figure 5: Upper controls limit of biscuit defects during November-December 2021.

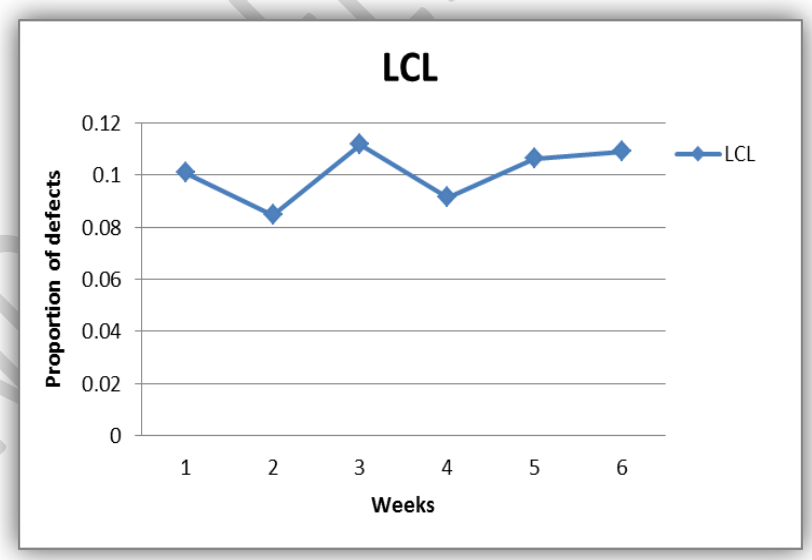

Figure 6: Lower controls limit of biscuit defects during November-December 2021

Eventually, the sampling of the product was done for six weeks. This allowed us to calculate the final product's rejection rate due to each type of defect. To compare the above graph slight difference between the defective biscuits by LCL and UCL.

VI CONCLUSION

From this exploration work, the following points can be concluded:

Based on the fishbone diagram we can see the factors that beget quality control are man, machine, work methods, materials, and work environment. Where is the biggest reason factor caused by workers who they are less focused or less skilled.

The number of weeks and defective biscuits should be duly good to use Statistical Quality Control (SQC) tools and software because quality is an important element in customer loyalty and the market's competitive advantage.

To avoid roasting and cracking of the biscuits, the baking process must be carried out at a specific temperature.

Based on the graph, the highest defect in the third week is caused by breakage, blisters, cream Oozing, hard bite, shrinkage, reverse shell, off registration, met layers, sealing defects, pinholes, overweight packages, and loose packing.

V REFERENCES

[1] Able, M. Charles. et. Al. 2011. “Initial investigation using statistical process control for quality control of accelerator beam steering”. Radiation Oncology 2011, 6:180 http://www.ro-journal.com/content/6/1/180. -4

[2] Bisgaard S, Statistical Tools for Manufacturing, Manufacturing Review, 6(3), 1993, pp. 192-200.

[3] Grant. E. L. and Leavenworth. R.S., Statistical quality control (4th ed., McGraw-Hill Co., New York, 1972).

[4] Harpreet Singh Oberoi, Mamta Parmar, Harpreet Kaur, Rahul Mehr, “SPC (Statistical Process Control): A Quality Control Technique for Confirmation to Ability of process,” International Research Journal of Engineering and Technology (IRJET), ISSN:2395-0072, Vol. 03, Issue: 06.

[5] Jukka Rantamäki Eeva-Liisa Tiainen Tuomo Kässi. 2013. "A case of implementing SPC in a pulp mill", International Journal of Lean Six Sigma, Vol. 4 Issue. 3, pp. 321- 337.

[6] MacCarthy Thananya Wasusri. B.L. 2002. "A review of non-standard applications of statistical process control (SPC) charts", International Journal of Quality & Reliability Management, Vol. 19 Issue 3 pp. 295- 320.

[7] Nurhasanah, N dan Diah Safitri. 2010. “Komponen Utama Pengendalian Kualitas Secara Statistik”. Semarang: UNDIP.

[8] Pranay S. Parmar, Vivek A. Deshpande, "Implementation of Statistical Process Control Techniques in Industry: A Review, "International Journal of Emerging Technologies and Innovative Research, ISSN: 2349-5162, Vol.1, Issue 6, pp. 583-587.

[9] Rajiv Sharma Manjeet Kharub. 2014. "Attaining competitive positioning through SPC – an experimental investigation from SME", Measuring Business Excellence, Vol. 18 Issue 4, pp. 86- 103.

[10] Solehatin Ika Putri, Chandra Budhi Septyandi, Dwi Phayana Rohandani, 2016. " Quality Control of Product: Statistical Process Control", Advances in Economics, Business and Management Research, Vol 15, pp; 259-267.

[11] W.A. Shewhart, Economic Control of the manufactured product's quality (D.Van Nostrand, Co., New York, 1931).

[12] Yas N. jaiswal, Vikram R. Khanzode.2020. "Defect rate reduction in Biscuit Production Industry using SPC Technique"International Journal of Engineering Research & Technology, Vol.9, Issue 11 pp. 578-586.