Case study

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

ABSTRACT

A business setting requires the practice of quality control to develop reliability, increase productivity and consumer consummation. The level of a lower control limit and an upper control limit in biscuit manufacturing and packing are considered. A total of 58000 biscuit packets are produced. Each week, 725 packets are inspected. Out of that number, 455 packets are defective. An inspection of certain randomly selected completed products will be conducted every week in this study.

Keywords: Quality control, biscuit manufacturing, Statistical quality control

I. INTRODUCTION

Quality products are those whose inherent characteristics meet consumer needs and increase profitability. No commercial event, whether manufactured or provided as a service, can be separated from its consumers. In today's information and technology-driven world, companies must compete with consumers who are more sensitive to quality when choosing products or services. To meet this condition, the business must take into account the quality of its products and intensify its efforts to produce quality goods or services, Each company identifies the importance of quality control, but approaches quality control differently [7,11].

Accordingly, quality control is crucial for the company, as satisfying the customer's needs will encourage consumers to buy the company's products. From the consumer, buying company can increase profits. Here a biscuit bakery, the Quality control functions will cover the following essentials: (i) All raw materials, including ingredients and packaging materials, should be specified and of high quality. (ii) Manufacturing and packaging equipment. (iii) Equipment maintenance. (iv) Process control throughout an industrial process.

To uphold high standards, all actions pertaining to quality control of the completed products should be cautiously reviewed. Before to delivery, the completed product should be examined for colour, texture, pellet size, strength, aroma, palatability, and chemical composition. Plentiful methods can be used to control the good of each characteristic. Using Statistical Process Control (SPC) in quality control means quality is controlled from the beginning of the manufacturing process, throughout the manufacturing process until the completed products [5].

Thru mathematics, there are several strategies for nice manipulation. Amongst one of the SPC equipment is a control plan which relies upon one has a look at saying that it is not easy to efficiently put into effect actual and sustainable control strategies. The manage diagram is one usually used device inside the measure and manages section.

Here are a few levels to progress a fine manage are particularly; Set your best standards, determine which high-quality standards to cognizance of, create operational tactics to supply first-rate, review your outcomes, get comments, make upgrades.

And here the variable is best to manipulate, wherein the pleasant control hassle is a hassle that cannot be measured without delay and want targeted signs to be measured absolutely. Therefore the hassle of fine manipulation is a hidden variable. An unknown variable is a formation variable that ought to be declared by means of the use of a trademark.

In this observation the size of a sample is the quantity of biscuit packs at some stage in the six weeks from November to December 2021. On this have a look at secondary information are used within the range of manufacturing, product defect, and the wide variety of samples [1, 2, and 3].

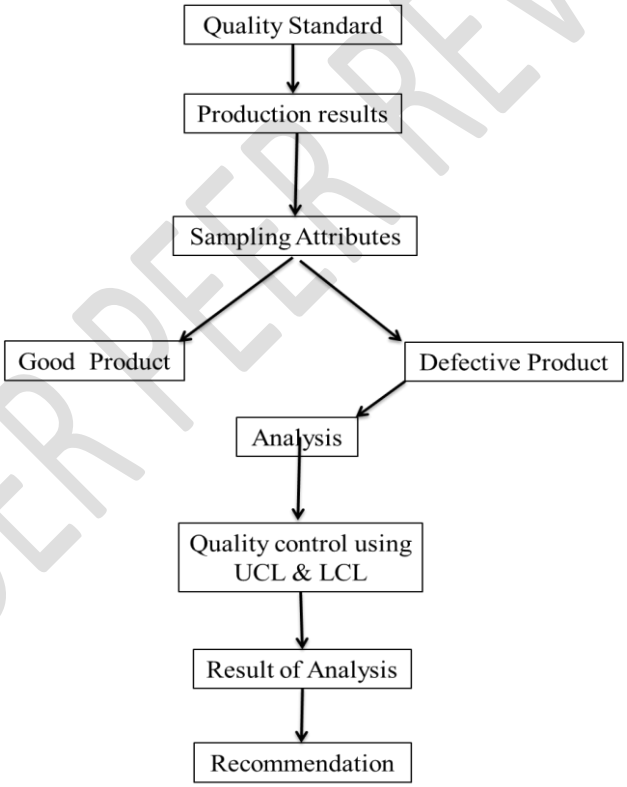

Fig 1: Flow chart for the Biscuit production process

In the beginning, 58000 numbers of packets had been accrued. Amongst that randomly 1.25% of packets are inspected in step per week. Of the overall inspected 10.45% of packets have defected and the defects may be categorized into main classes, specifically biscuit defects and packaging defects. These categories of defects may be additional damaged down as follows:

Packaging faults: 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 subsequent step, the sampling of the product becomes done for 6 weeks. This allowed us to calculate the final product's rejection fee because of every form of defect, as proven in table 1.

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

Kind of defects	**W-I**	**W-II**	**W-III**	**W-IV**	**W-V**	**W-VI**	**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	4350
Total Production	58000	58000	58000	58000	58000	58000	3,48,000

After the check sheet is done subsequent step is to produce a graph. That graph is beneficial to get wherein week are extra faulty biscuits [11].

B. Beget and Effect Diagram

An unproductive illustration or fishbone diagram fig.2, fig.3 & fig.4 were made to have a look at the elements that end up the motive of product defects. The elements that affect and beget imperfect merchandise can normally be categorized as man, cloth, device, method, and surroundings.

This instance is a graphic tool used to analytically classify implicit reasons for a sure shape of the defect, signifying a reason-and-impact correlation between hypotheses. Even though the purpose -and-impact graphs show a couple of variables that need to be studied, the focus is on the most possible cause(s) that ultimately leads to the rejection of the substance. A purpose-

and-effect illustration for the three primary kinds of defects from table 1 has been organized for this evaluation, particularly Breakage, Sores, and rancid registration [13].

Breakage: Machine misalignment, improper baking, absence of care, absence of ergonomic considerations, absence of operator expertise, and improper handling of equipment is the crucial causes of breakage defects.

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

Off Registration: The root causes of off registration defects in the packing process are poor gear conditions, faulty web page, and incorrect tolerances in measuring tools, insufficient operator training.

The production, the breakage defect, blistering defect, and registration defect process are shown in the following fishbone diagrams

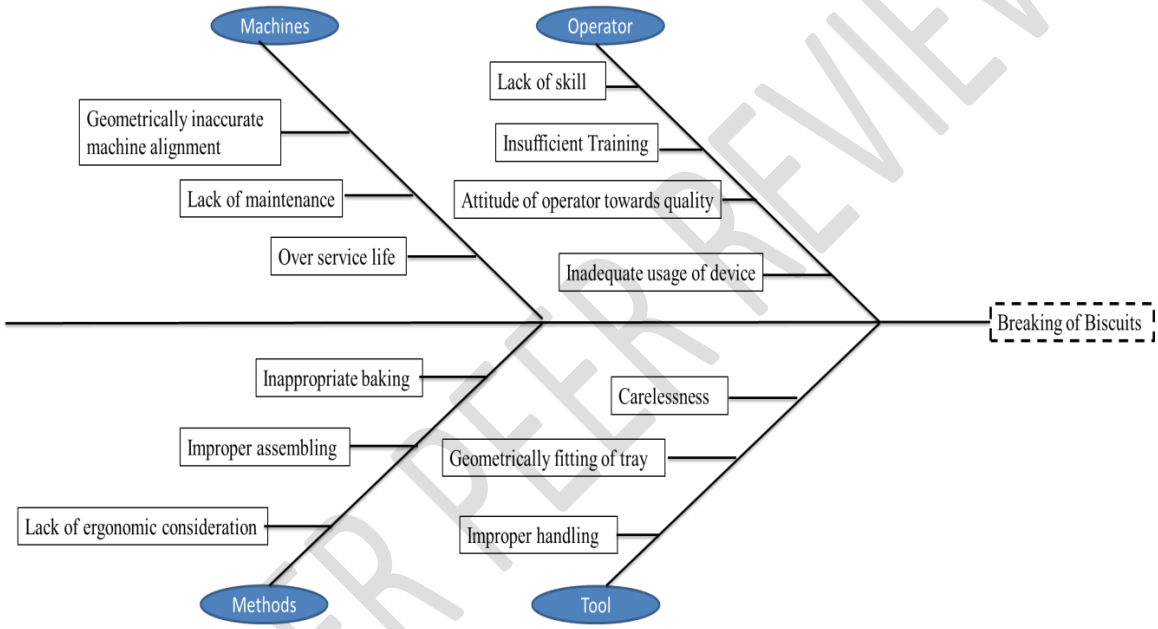

Fig 2: Beget and effect diagram for breakage defect

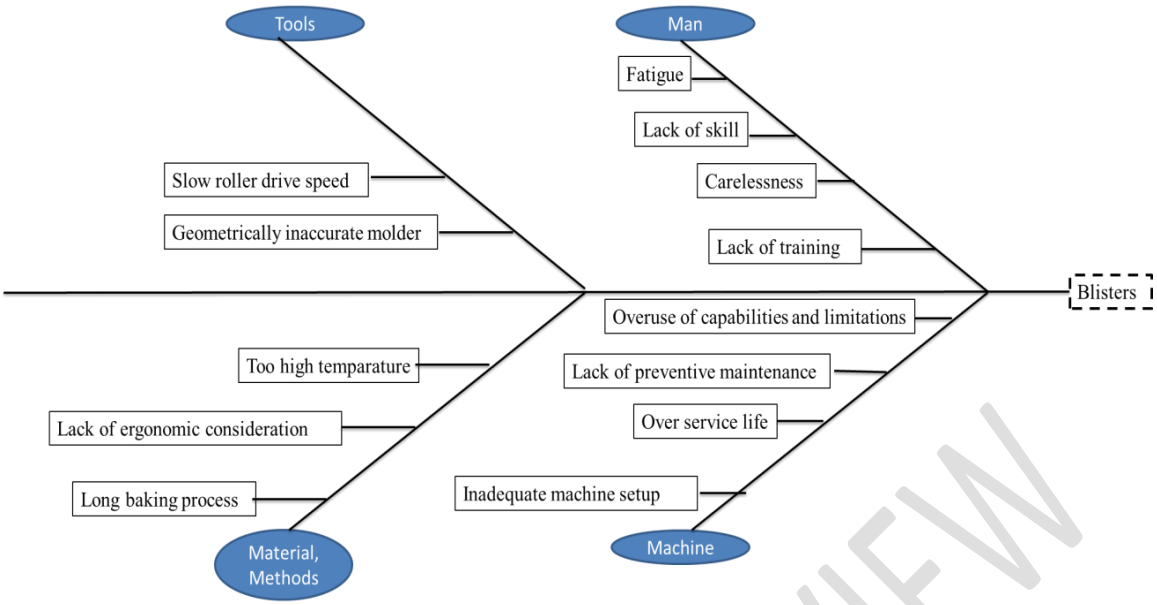

Fig 3: Beget and effect diagram for blistering defect

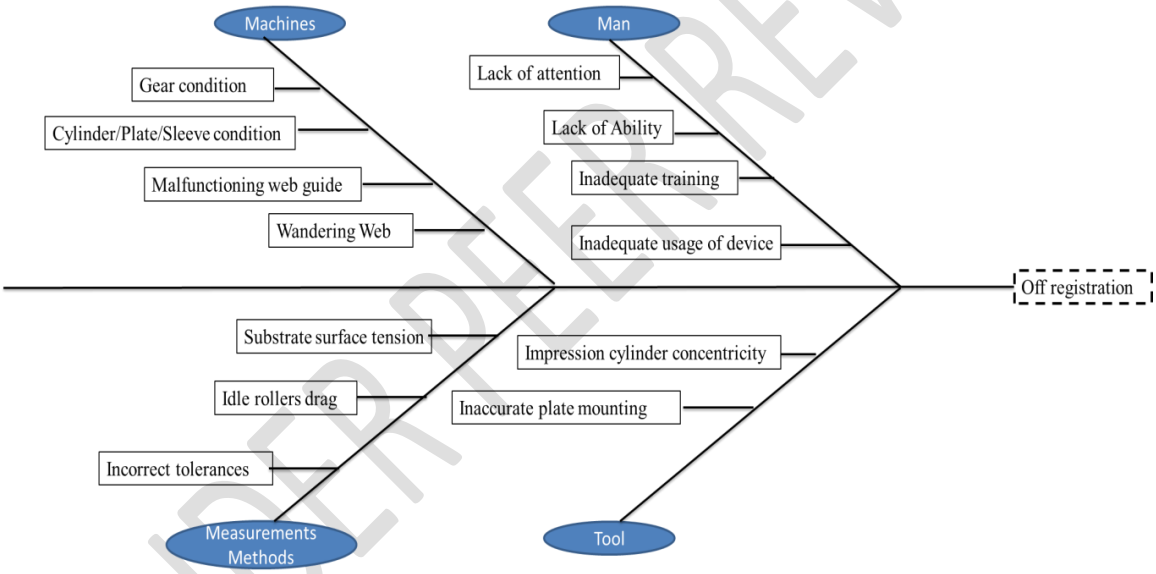

Fig 4: Beget and effect diagram for off registration defect

III RESULT AND DISCUSSION

Quality control of the completed product is done through the inspection. According to the components within the machine setting the characteristics of good quality biscuits are examined. From the production, the breakage defect, blistering defect, and registration defect are shown in the above fishbone (Fig.2, Fig.3 & Fig.4) diagrams.

So the first stage taken to analyze statistical quality control is to create a table (check sheet)of the production quantities and product defects / incompatible with quality principles.

Table. 2. *Percentage of defective Biscuit production in 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 among the upper control limit (UCL) and lower manipulate limit (LCL). The centerline is a line that represents the common 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. 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 fig. 5 & fig. 6 below.

Table 4: Lower and Upper control limit of defectives

No. of 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

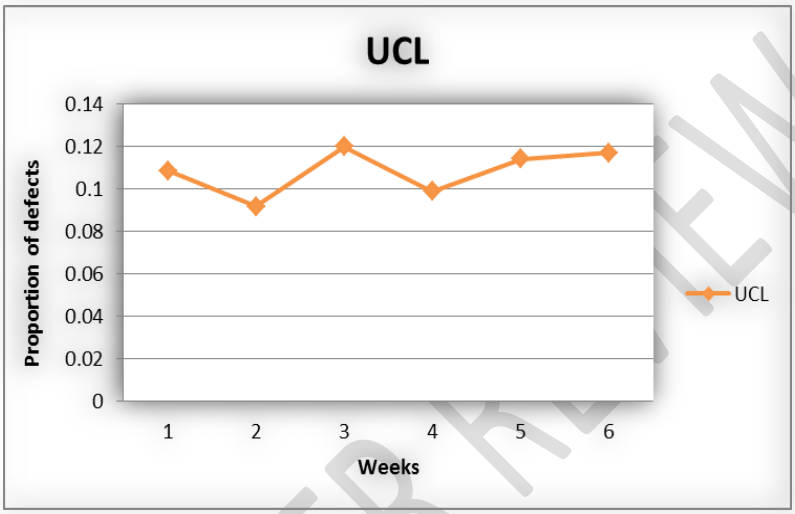

Fig 5: Upper controls limit of biscuit defects during November-December 2021.

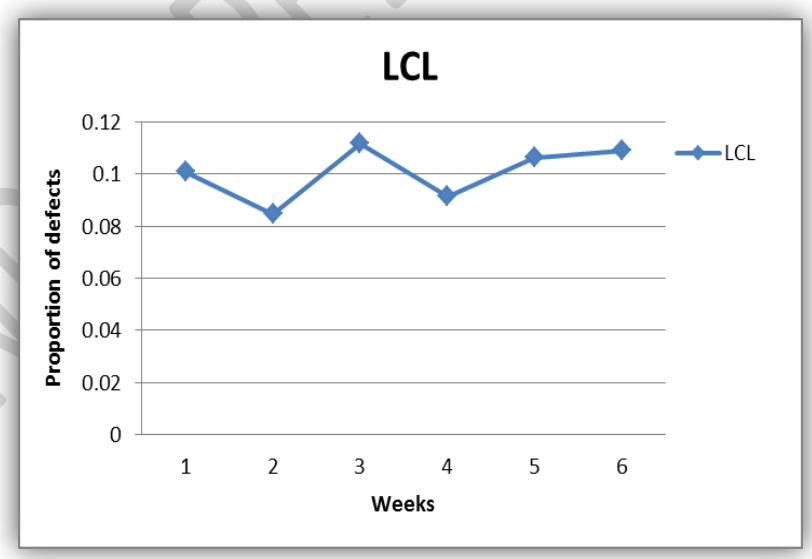

Fig 6: Lower controls limit of biscuit defects during November-December 2021

Ultimately, the sample of the product was done for 6 weeks. This permitted us to examine the final product's rejection rate due to each type of defect. To have a look at the above graph mild difference among the defective biscuits through lower control limit (LCL) and upper control limit (UCL).

VI CONCLUSION

The following opinions can be concluded from this exploration work,

The wide variety of weeks and defective biscuits should be duly good to use Statistical quality control (sq.) gear and software program. Because quality is an essential element in customer loyalty and the marketplace's competitive advantage.

Here 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 and it can be shown in fig.5 & fig.6 respectively.

Based on the fishbone diagram we can see the factors that beget quality control are guy, machine, work methods, materials, and work environment. To avoid roasting and cracking of the biscuits, the baking process must be carried out at a specific temperature. This incidence can be occurred by the workers who are less targeted or less skilled.

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