Application of Quality Control Techniques on Can Malt Produced at International Brewery Plc, Ilesha, Osun State, Nigeria.

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ABSTRACT: This paper is aimed at apply statistical quality control tools to International Breweries plc, Omiasoro, Ilesa Osun State, Nigeria on the malts product in order to monitor the volume, dispersion in the filling process, thereby reducing the stress of final inspection of products produced. This research paper covers only the machines processing line i.e. its processes in beverages section of Beta-Malt production process line of the company. The findings showed that the R-chart has LCL of 0.0000, CL of 1.5806, while the UCL of 3.3423, and $\bar{x}$ −Chart, has LCL of 31.7044, CL of 32.6161, while the UCL of 33.5279 at 3-sigma of the inspected Malt produced at International Brewery, Ilesha, Osun-State, Nigeria.

Keywords: Quality Specification, Control Points, Upper Control Limit, Lower Control Limit

INTRODUCTION

Quality control (QC) is not an optional extra in food processing; neither is it something done only by large manufacturers. It is an essential component of any food processing business.

Quality control need not be time consuming or expensive, and the results of quality control tests should help save money in the long run. In general, quality control procedures should be as simple as possible and only give the required amount of information. Too little information means the test has not done its job; too much information and management decisions may be delayed or confused.

Quality control is used to predict and control the quality of processed foods. It is no use producing a food, testing it to find the quality, and then trying to find a buyer for that particular batch of food. Quality control is used to predict the quality of the processed food and then control the process so that the expected quality is achieved for every batch. This means that quality specifications must be written and agreed with suppliers or sellers, and control points must be identified in the process (Barrie, 2003).

Quality Specifications

The quality of foods and beverages or ingredients can be measured in different ways but one popular method is to describe 'quality attributes', and specification can then be written and agreed with the supplier or seller, which lists the quality attributes that are required in a food(Tony Swetman, 2008).

Control Points

In every food process there are particular stages which affect the quality of the final product. For example, the amount of heating given to pasteurized juices affects their color, flavor and storage life; in sausage making, the amount and type of grinding affects the texture of the meat. Such stages are identified as control points, and quality control checks are made at these points in order to control the process.

Manufacturers therefore need first to identify the control points in their process - using outside technical assistance if necessary - and then to set up a specification for operators to use. For example, in jam

making, the amount of pectin, fruit and sugar should be carefully controlled: therefore, the weighing of ingredients is a control point, as the weights of each ingredient must be specified and carefully weighed out.

In the same way, other control points would be: the acidity of the jam, the sugar content after boiling and the temperature of filling. The mix should be checked for correct acidity, the sugar content checked during boiling (using a thermometer or refractometer), and the temperature checked before filling (using a thermometer).

International Breweries plc is a brewery in Nigeria. It began production in December 1978 with an installed capacity of 200,000 hectolitres per annum, this increased to 500,000 hl/a in December 1982. On 26 April 1994 International Breweries plc became a public limited liability company and listed on the Nigerian Stock Exchange. International Breweries plc has a technical services agreement with Brauhaase International Management GMBH, a subsidiary of Warsteiner Group of Germany, which owned 72.03% equity. On 1 January 2012, SABMiller took operational management control of International Breweries from BGI Castel.

OBJECTIVES OF THE STUDY
The aim of this study is to apply statistical process control (SPC) as a quality control tool to International Breweries plc, Omiasoro, Ilesa, Osun State, Nigeria beverages product in order to monitor the volume, dispersion in the filling process, thereby reducing the stress of final inspection of products produced.

Objectives of the study are to:
   i.   establish the upper and lower control limits of machines processing lines using SPC technique as QC tool.
   ii. construct the $\bar{X}$ – bar and R chart QC charts of the process and then use it to detect or identify the cause of variation (if any) in the production process.

LITERATURE REVIEW
In this aspect, the theoretical frame works will be discussed. Area such as quality control and its tools, SPC and some other aspects of quality management system (QMS) will be considered. Moreover, they are presented in order to form a filter through which the empirical work and results will be formed and analyzed. Although literature in this field „Statistical Process Control" here in Nigeria has not been extensively documented according to Akinola (2009), but in as much as meeting up with quality demand is a concerned to every organization,

reviewing other people's progress in this regard will not be a waste. However, doing so will be an eyes opener. Marilyn and Robert (2007), says the foundation for Statistical Process Control technique as quality control tool was laid by Walter Shewart who worked at the Bell Telephone Laboratories in the 1920s when conducting research on methods to improve quality and lower costs. Accordingly, he developed the concept of control with regard to variation, and came up with Statistical Process Control Charts which provide a simple way to determine if the process is in control or not. Dr. W. Edwards Deming built upon Shewart's work and took the concepts to Japan following World War II (WWII). There, Japanese industry adopted the concepts whole-heartedly. The resulting high quality of Japanese products is world-renowned. Dr. Deming is famous throughout Japan as a "God of quality". Today, SPC is used in manufacturing or a production facility around the world in order to improve the quality service delivery to the customers (Douglass, 2009).

Here in our country Nigeria, this method (SPC) has been used in some industries such as banking, Food manufacturing, and educational sector in order to improve their quality delivery. For instance, Akinola G.O. (2009), examines the characteristics of a good quality service and methods used in controlling quality of service in the Nigerian Banking industry using the technique of quality control. She found out that most banks do not use the QC technique to improve their services to the populace. Based on her finding, she recommended that banks should improve their service delivering system using statistical process control mechanism. Obadara and Alaka (2013), investigated the impact of accreditation on quality assurance in Nigerian Universities using Statistical Quality Assurance (SQA) technique of quality control. Their findings revealed that there is significant relationship between accreditation and resource input into Nigerian universities, quality of output, quality of process, and no significant relationship between accreditation and quality of academic content. Furthermore, they noted that quality of education could be measured in terms of quality of input, quality of output, quality of content and quality of process. Therefore, these parameters were used by the study to assess quality assurance.

Payam and Reza (2009) use the application of SPC technique to examine the QC in cable industry, a case study of Copper Consumption Reduction in Nexans IKO Sweden. The study find out that the quality of cable products been produced can still be better enhanced. Furthermore, the study recommended that management must make a commitment to understand and reduce all process variation as much as possible in order to improve the quality of the product.

Hence, Management must allow the local work force the time to understand process variation and make corrections, when necessary, in order to restore stability-not to just make adjustments to compensate for the lack of stability. These reviews indicate that quality is a concern to everyone, be it an organization (private or public), Individual, corporate body. Hence, it worth to look upon quality in order to remain in a competitive market.

The reduction of variation is done by actions such as eliminating special causes or designing a newly improved system with smaller variability and all these are done through statistical thinking and modeling. Everything (manufacturing or non-manufacturing) must be regarded as a process, and there are always variations. In a manufacturing process, variation is caused by machines, materials, methods, measurements, people, and physical and organizational environment. In non-manufacturing or business processes, people contribute a lot to the total variation in addition to methods, measurement and environment. These entire variations encounter by both manufacturing and non-manufacturing process are best analyzed using statistical techniques (Tamini and sebastianeill, 2016).

Quality as a concept has been defined differently by different stakeholders. Most people have a conceptual understanding of quality as relating to one or more desirable characteristics that a product or service should possess. This is because it is multidimensional and mean different thing to different people. Obadara and Alaka (2013), says quality can be defined as "fitness for purpose". It encapsulates the concept of meeting commonly agreed precepts or standards. Such standards may be defined bylaw, an institution, a coordinating body or a professional society. Akinola (2009), Quality is the ability or degree with which a product, service, or phenomenon conforms, to an established standard, and which makes it to be relatively superior to others. With respect to SPC, this implies the ability or degree with which the operating process conforms to the established standard and appropriateness, of the inputs available for the delivery of the system. Chandra (2001), says Quality can be defined in many ways, ranging from "satisfying customers" requirements" to "fitness for use" to "conformance to requirements." It is obvious that any definition of quality should include customer and satisfaction which must be the primary goal of any business.

METHODOLOGY

This paper presents the methodological approach including empirical and materials used in this research work. The paper further established all the necessary parameters such as the Mean, Range, construction of charts and Process Capabilities index values (CP_k) needed in this work in order to achieve the stated objectives.

1. Descriptive Statistics: Are Statistics used to describe quality characteristics and relationships. Included are statistics such as the mean, standard deviation, the range, and a measure of the distribution of data.
(a) The Mean- measures the central tendency of a data. Mathematically;

$$\bar{X} = \frac{\sum_{1=1}^{n} X_i}{n} \qquad \text{Where, } \bar{X} \text{is the mean}$$

Σ is the sigma denoting summation of X_1, X_2, X_3, X_4, up to X_n. and n is the total number of items in the data

b. The Range: is the simplest and most straight forward measure of dispersion. It is the difference between the maximum (largest) and the minimum (smallest) values in the set of data. Mathematically thus given as: Maximum (Largest) – Minimum (Smallest)

Mean (x-Bar) Charts for Variables

A mean control chart is often referred to as an x-bar chart. It is used to monitor changes in the mean of a process. To construct a mean chart, first it is needed to construct the center line of the chart. The center line of the chart is then computed as the mean of all $\varkappa$ sample means, where $\varkappa$ is the number of samples:

$$\bar{\bar{X}} = \frac{\bar{X}_1 + \bar{X}_2 + \cdots \bar{X}_{\varkappa}}{\varkappa}$$

To construct the upper and lower control limits of the chart, the following formulas are used:
Upper Control Limit (UCL) $= \bar{\bar{X}} + \Box\sigma_{\bar{x}}$
Lower Control Limit (LCL) $= \bar{\bar{X}} - \Box\sigma_{\bar{x}}$
Where $\bar{\bar{X}}$ = the average of the sample mean, n = sample size (number of observation per sample)

Range (R) Charts for variables

Range (R) charts are another type of control chart for variables. Whereas x-bar charts measure shift in the central tendency of the process, range charts monitor the dispersion or variability of the process. The method for developing and using R-charts is the same as that for x-bar charts. The center line of the control chart is the average range, and the upper and lower control limits are computed as follows

$$CL = \bar{R}$$
$$UCL = D_4\bar{R}$$
$$LCL = D_3\bar{R}$$

Where values for D4 and D3 are obtained from already established statistical tables.

As earlier defined, the range is simply the difference between the largest and smallest values in the sample. The spread of the range can tell the variability of the data. In this case control limits would be constructed as follows:

Upper Control Limit (UCL) $= \bar{\bar{X}} + A_2\bar{R}$

Lower Control Limit (LCL) $= \bar{\bar{X}} - A_2\bar{R}$

Where, $\bar{\bar{X}}$ = average of the sample means

$\bar{R}$ = average range of the samples

A_2 = factor obtained from standard tables which is a factor that includes three standard

deviations of ranges and is dependent on the sample size being considered.

ANALYSIS

The table below shows data collected for Thirty – One (1st October – 31st October, 2020) samples days taken by the Quality Control Inspector of the company with five observations (the numbers of machines) each of the volume of Can Beta-Malt filled in cl.

Days	Samples Inspection (cl)				
	x_1	x_2	x_3	x_4	x_5
1 – 10	33.5	31.5	32.5	33.5	31.5
2 – 10	31.5	31.5	32.5	32.5	32.5
3 – 10	32.5	33.5	33.5	33.5	33.5
4 - 10	33.5	32.5	33.5	33.5	33.5
5 – 10	31.5	33.5	32.5	32.5	31.5
6 – 10	32.5	33.5	31.5	32.5	31.5
7 -1 0	33.5	32.5	31.5	32.5	32.5
8 – 10	32.5	32.5	32.5	31.5	32.5
9 – 10	32.5	32.5	32.5	31.5	32.5
10 -10	32.5	31.5	32.5	33.5	33.5
11 -10	33.5	33.5	33.5	32.5	33.5
12-10	32.5	33.5	31.5	32.5	31.5
13-10	31.5	32.5	33.5	31.5	31.5
14-10	33.5	32.5	33.5	31.5	32.5
15-10	32.5	31.5	32.5	32.5	31.5
16-10	33.5	31.5	33.5	32.5	32.5
17-10	33.5	32.5	32.5	32.5	33.5
18-10	32.5	33.5	32.5	33.5	33.5
19-10	32.5	32.5	32.5	33.5	32.5
20-10	33.5	31.5	33.5	32.5	32.5
21-10	32.5	31.5	31.5	32.5	33.5
22-10	32.5	31.5	32.5	33.5	32.5
23-10	33.5	31.5	31.5	32.5	32.5
24-10	33.5	32.5	32.5	32.5	33.5
25-10	32.5	32.5	33.5	33.5	31.5
26-10	31.5	33.5	33.5	33.5	32.5
27-10	32.5	32.5	33.5	33.5	31.5
28-10	33.5	33.5	32.5	32.5	33.5
29-10	32.5	32.5	32.5	31.5	32.5
30-10	33.5	32.5	33.5	31.5	31.5
31-10	33.5	31.5	32.5	32.5	33.5

Source: International Breweries Plc, Omiasoro Ilesa, Osun State, Nigeria (Survey, 2020)

ANALYSIS

Control Chart: sample inspections

Control Chart: Sample inspections
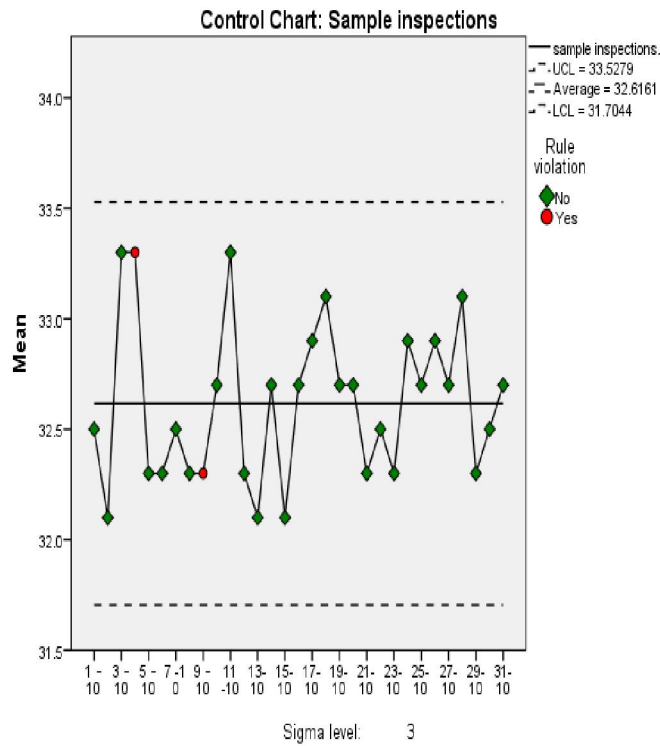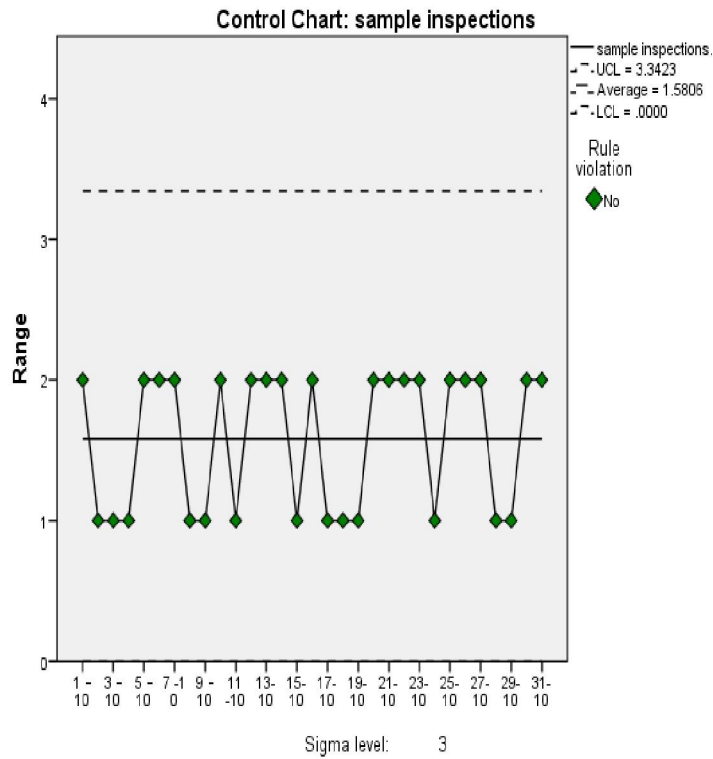
Rule Violations for X-bar

UNITS	Violations for Points
4 - 10	2 points out of the last 3 above +2 sigma
9 – 10	4 points out of the last 5 below -1 sigma

 2 points violate control rules.

SUMMARY OF FINDINGS

The following were the findings from the SPSS version 23 analysis:

(i) For R-, the Lower Control Chart is 0.0000, the Central Limit or average is 1.5806, while the Upper Control Limit is 3.3423, and no rule of violation detected from 3-sigma range chart.

(ii) For $\bar{x}-$Chart, the Lower Control Limit is 31.7044, the Central Limit/Average is 32.6161, while upper control chart is 33.5279 at 3-sigma $\bar{x}-$ Chart. Meanwhile, there are 2 points out of last 3 above +2-sigmal (the 4th of October, 2020 samples inspected) and 4-pionts out the last 5 below -1 sigma(on 9th of October, 2020 samples inspected).

CONCLUSION

So far the results from previous analysis showed that both x-bar control and R- control charts revealed that the sample inspected at International Brewery Plc, Ilesha, Osun State products are under statistical control since all the points are within the control limits in both cases.

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APPENDIX: DATA

Data collected for Thirty – One (1st October – 31st October, 2020) samples days taken by the Quality Control Inspector of the company with five observations (the numbers of machines) each of the volume of Can Beta-Malt filled in cl.

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9 – 10	32.5	32.5	32.5	31.5	32.5
10 -10	32.5	31.5	32.5	33.5	33.5
11 -10	33.5	33.5	33.5	32.5	33.5
12-10	32.5	33.5	31.5	32.5	31.5
13-10	31.5	32.5	33.5	31.5	31.5
14-10	33.5	32.5	33.5	31.5	32.5
15-10	32.5	31.5	32.5	32.5	31.5
16-10	33.5	31.5	33.5	32.5	32.5
17-10	33.5	32.5	32.5	32.5	33.5
18-10	32.5	33.5	32.5	33.5	33.5
19-10	32.5	32.5	32.5	33.5	32.5
20-10	33.5	31.5	33.5	32.5	32.5
21-10	32.5	31.5	31.5	32.5	33.5
22-10	32.5	31.5	32.5	33.5	32.5
23-10	33.5	31.5	31.5	32.5	32.5
24-10	33.5	32.5	32.5	32.5	33.5
25-10	32.5	32.5	33.5	33.5	31.5
26-10	31.5	33.5	33.5	33.5	32.5
27-10	32.5	32.5	33.5	33.5	31.5
28-10	33.5	33.5	32.5	32.5	33.5
29-10	32.5	32.5	32.5	31.5	32.5
30-10	33.5	32.5	33.5	31.5	31.5
31-10	33.5	31.5	32.5	32.5	33.5

Source: International Breweries Plc, Omiasoro Ilesha, Osun State, Nigeria. (Survey, 2020)

10/23/2021