STATISTICAL QUALITY CONTROL IN A BOTTLING COMPANY

BY

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CERTIFICATION

This is to certify that this Research work was carried out **ABDULWAHAB MUDASHIR OMOBOLAJI** with Matric No **ND/23/STA/FT/0110** and has been read, corrected and approved as meeting the requirement for the award of National Diploma in statistics, Institute of Applied Sciences.

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DEDICATION

This project is dedicated to Almighty God, the most gracious and the most merciful, in whom I consistently trust and who has strengthened me in the fulfillment of this programme.

ACKNOWLEDGEMENT

In the name of God, the most merciful and the most beneficent. I thank Him for sparing my life throughout this project and making it possible for me to complete my programme successfully.

I also thank my indispensable parent who finance and support me before and during this programme. May God continue to provide for them abundantly, shower his mercies and blessing on them and grant them long life to reap the fruit of their labor(Amin).

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ABSTRACT

This research investigates the application of Statistical Quality Control (SQC) techniques in Seven-Up Bottling Company, Ibadan, Oyo State, with emphasis on maintaining product consistency and minimizing production defects. Bottling companies face challenges such as variations in fill volume, crown cork sealing, gas pressure, and labeling, which can significantly impact customer satisfaction and operational efficiency. In this study, production data were collected from the Ibadan plant and analyzed using control charts, histograms, and process capability indices to determine whether the processes conform to standard quality requirements. The normality assumption was tested to validate the reliability of the data. The analysis revealed that while the majority of operations remained within control limits, occasional assignable causes of variation occurred, necessitating corrective actions. Findings emphasize the need for continuous process monitoring, staff training, and prompt identification of deviations to sustain quality standards. The study concludes that effective adoption of SQC tools in Seven-Up Bottling Company is essential for reducing waste, improving productivity, enhancing customer confidence, and ensuring competitiveness in the beverage industry.

Keywords: Maintaining Product Consistency, Minimizing Production Defects, Variations in Fill Volume, Crown Cork Sealing, Improving Productivit

CHAPTER ONE

1.0 Introduction

1.2 Background of Study

For statistical purpose the term production requires careful definition. Thus, from the economic point of view any goods or services produced and exchanged for income constitute, "production of an industry". It includes the activities of manufacturers and all other purposeful activities or services rendered for human consumption (Musa *et al.,* 2015). In production, products are said to be incomplete until products and services get to the final consumers for maximum utility. The process is further justified if consumers appreciate the manufactured goods and services brought to them, thus the vision of any industry producing or manufacturing of any goods and services to geared towards product quality, improvement and consumers' maximum satisfaction. This brings about competition among industries (Aruleswaran., 2004). So, the application of statistical quality control is an aspect of production in manufacturing industry. Several measures are employed in order to improve the quality of raw materials used during the course of production. In order to satisfy the consumers, there have been conscious move and ideas to ensure that the quality of goods produced are standardized. This gives rise to the use of statistical quality control (Adeoti *et al.,* 2013).

Determination of the best point for quality control depends on the type and the process that prevail in or within the firm. Every organization in the private sector exists to satisfy the demand for its products and services at a profitable level.

1.2 Aims and Objectives

In order to accomplish any task effectively, it is necessary to plan the required cause of action. Thus the aims and objectives are;

- To check whether the different quality characteristic variable like Brix (sugar), carbon dioxide, temperature and pressure are under statistical quality control or not.
- The study will also try to find the cause of any deviation and suggest solutions to the deviations.
- To check whether the soft-drink conform to the standard set by the organization of Nigeria.

1.3 Statement of the Problem

When we are involved in any production processes, the results are affected with some factors. These factors could be due to common causes, that is, randomly occurring variations or assignable causes of variation are sub-standard or defendable raw materials, negligence of operators, improper handling of machines, unskilled or un-experienced technical staff. These have led to the use of statistical process control to study the production process of coke, a product of the Seven up Bottling Company (SBC) Plc, to' know based on the data collected, if the established standards in quality are being met at all times.

1.4 Significance of the Study

This study on Statistical Quality Control (SQC) in Seven-Up Bottling Company (SBC) Plc, Ibadan, is of great significance to both the company and the manufacturing industry at large. In today's competitive market, quality is a key determinant of success, especially in the beverage industry where consumer safety, satisfaction, and brand loyalty are paramount. By focusing on SQC, this research seeks to show how the use of statistical methods can improve the quality of production processes, reduce variability, and ensure that products meet consistent standards.

The study is particularly beneficial to the management of Seven-Up Bottling Company, as it provides data-driven insights into production performance and areas where defects or

inefficiencies may be occurring. These insights can support more informed decision-making, enhance process control, and contribute to cost savings by minimizing waste and rework. Moreover, the application of SQC helps ensure compliance with both national and international quality standards, which is essential for sustaining consumer trust and expanding market reach.

For the academic community, this research contributes to the growing body of knowledge in quality management and industrial statistics. It provides a practical example of how theoretical statistical tools are applied in real-world production environments. Additionally, it serves as a useful reference for other bottling and manufacturing firms aiming to improve their quality assurance processes.

1.5 Justification of the study

The Seven up Bottling Company (SBC) Plc, Ibadan Oyo State, will definitely benefit from the funding of this study, they would be advised on the control chart that would be used to check both process mean and process variability, which will help to produce improved and acceptance quality of their product.

1.6 Scope and Limitations and of the study

The variables to check are Brix (sugar) measured in degree, temperature measured in ^{O}c, carbon (iv) oixde measured in %, and pressure measured in Bars. The period of study covers the production carried out from to May 1st to May 31st. The major limitation encountered was mainly lack of trained statisticians in the company's record department. Thus, the samples taken were not randomized properly. As a result, this caused random and arrangement errors.

1.7 Definition of terms

1. **Statistical Quality Control (SQC):** A set of statistical methods used to monitor and

control the quality of production processes. In a bottling company, it's used to ensure bottles are consistently filled, sealed, and labeled according to standards.

2. **Quality**: it is a degree to which a product, service, or process meets specified requirements and satisfies customer expectations. It involves measuring, analyzing, and improving how consistently and accurately outcomes align with standards.
3. **Control**: it’s refers to the monitoring and regulation of a process to ensure that it operates consistently and produces results within acceptable limits.
4. **Control Chart**: A graphical tool used to track process data over time. It helps detect trends, shifts, or any abnormal behavior in the bottling process like fluctuating fill levels.

CHAPTER TWO

Literature Review

2.0 Introduction

The initiative for creation of an industry in a nation is to produce very high quality goods which came from the realization of the federal government, that establishing an industry by private se'ctor and public sector is an instrument of economic development and self-reliance. Thus, the importance of statistical process control procedures in industries is widely accepted, due to the fact that it has been a quality or standard improvement technique in many industries.

2.1 Literature Review

In carrying out a work of this magnitude, an acknowledgment and appreciation of previous or existing works relevant to this study is of great importance. Walter A. Shewhart (1924) was the pionner of the statistical quality control technique, and it was during world war II that its greatest development took place in the bell telephone laboratory.

Oakland, (1990), for sample size up to n=12, the range method of estimating O is relatively efficient. For values of n greater than 12, the 'range losses effectiveness rapidly as it ignores all the information in the sample between the highest and lowest values. For the sample sizes (n=4 or 5) often employed on variables control charts. It is entirely satisfactory. He also stated that a very important piece of theory in statistical quality control is the central limit theorem.

This states that if a sample size of n is drawn from population with mean N and a'standard deviation O, then as n increases in size, th.e distribution of sample mean approaches a normal distribution with mean N and standard error of the mean O/n, this implies that even if the individual values are not normally distributed, the distribution of individual means will tend to have a normal distribution and the larger the sample size, the greater will be the tendency.

Nwodo J.U. (1980) in his study of performance of students' graduation in various department of the faculty of physical sciences, University of Nigeria Nsukka used statistical quality control to analyze his data. Based on the period of years under study be concluded that performance of students at graduation was constant. Eke (1996) in his study of quality control of Ada-palm (palm oil and palm kernel) used statistical quality control to carry out his analysis. He came up with the conclusion that the production process was out of control within the period of 1993-1995.

Mgbojiwe, (1986) in his study of quality control of Ebony paints used statistical quality control to carry out his analysis. He came up with the conclusion that Ebonyi paints is not of a required quality standard and may not be considered as a quality paint.

2.1.1 Origin and Development of Quality Control

Despite the several definitions of adverse interest, there is a standard acceptable definition of quality control, which is consumers' satisfaction. The fact that a group of individuals or an organization has to ensure (hat a product meets an optimum or specified standard viewed alongside this perspective, quality control is almost, if not exactly as old as human race, it is quite logical to say that in every day activity the act of quality control is also the nature of the activities.

An archeological finding, however, shows that the remains of ancient structure indicates that by the time of the construction of the Egypt Pyramid and the age of the pyramid, the flawlessness of the classical Greek master work and the endurance of the Roman structure are being agented for the conscious effort of quality control, therefore it can be deducted that the ancient Egyptians were involved in the earliest known formalized quality control. The legacy of quality control also extended to engineering and architecture sphere of Romans regions. The high quality of these structures gained their influence like models of famous religion edifies and for great modern

structure such as railway terminals, which have remained unsuppressed In durability. Other evolution and development of quality control occurred over a long period of time.

Feignenbanm (1983) identified this stager as operation foreman, inspection, statistical total and organization mode total quality control management. In the Middle Ages and up to 1800s, the supply of services and the production of goods were essentially limited to single individual or to group of people.

The individual was both the producer and the inspector. The 1940s saw the birth of statistical quality control, a development and expansion of industries were experienced during the second world war, the family quality of goods then necessitated training programmed census on control chart, statistical quality control and acceptance. Sampling plans were taught throughout the state. When acceptance sampling was published, various quality control societies came together in 1946 and formed American socie0ty of quality control (ASQC). Awareness of the dissemination came into Japan in 1980 through Denning who was an instrument to the dissemination and population, e.g: the practice by teaching series of courses on statistical method.

2.1.2 Importance of Statistical Quality Control

The importance of statistical quality control cannot be over emphasized, that it cannot be pushed to the background and a few of such importance are:-

1. To provide a basis for inspected manufactured or purchased goods.
2. Secure information to be used in establishing or changing production procedures, such changes may be the elimination of special causes of variation otherwise-termed or possible changing the fundamental method of production.
3. To familiarize personnel with the use of control chart, although this word seems to be a legitimate purpose only in the early stage of statistical quality control technique in any

organization control chart undertake for this purpose most often disclose opportunity for cost savings.

4. One of the major importance of statistical quality control is the reduction of wasted time and material to an absolute minimum level, since faulty production is immediately dictated and the causes removed.

Quality control is a production function in which performance is measured and corrective actions are taken to ensure the accomplishment of organizational goals as a result of pointing out errors and weakness and rectifying the situation in order to prevent reoccurrence. It is a policing operation in production, although it is not restricted alone as we knowingly or unknowingly apply quality control measures to our day to day endeavour. Quality control is also forward-looking, in which those involved seek to anticipate deviation and therefore prevent it. It enables those in change of production in an industry to verify whether variations in the quality production are attributes to change or assignable causes. Quality control measures are for the survival of any organizations, it is means in which confidence is gained by the survival of any organization in terms of defending their product. Quality refers to how well a product or services confirms within organization, it is a process whereby groups are able to initiate, regulate the standard of the organization.

2.2 An Overview of Seven Up Boiling Company (SBC) Plc

Production of its first product, 7 Up started on October 1, 1960. The venture was a brainchild of the El-Khalil family from Lebanon. The family patriarch had founded a transport firm in Nigeria and then decided to divest into the soft drink market to compete with Leventis led Nigerian Bottling Company (NBC). In the 1960s, the firm introduced a brand of howdy products including Howdy, Crush, Howdy Tonic Water, and Howdy Ginger Ale. The firm's initial market was within Mid-

West and Western Nigeria due to the location of its factory at Ijora, Lagos. To raise awareness and compete with NBC, they distributed outdoor branded kiosks to retailers.

In the 1970s, after the government promulgated an indigenisation decree, El-Khalil family sold their transport business and concentrated on the bottling business. Faysal El-Khalil, who managed the transport firm, joined Seven-Up and later became its managing director. As the purchasing power of consumers increased, the firm embarked on an expansion programme at the beginning of Nigeria's oil boom during the 1970s. A new factory was built in Oregun and followed by one at Ibadan and then at Aba. The company's push for nationwide coverage has led to factories being built in Kano, Kaduna, Enugu, Benin and Ilorin. Many of its expansion programs were financed with debt.

Seven up Bottling Company today, is one of the best bottler of soft drinks, selling more than 7.5 million bottles per day. Other products bottled by Seven up Bottling Company includes; 7-Up, Pepsi, Mirinda, Teem, Supa Komando and Mountain Dew. Quality generally refers to those product features, which meet the needs of customers and thereby provide product satisfaction. Control means to administrate, manage, direct or regulate to achieve excellence of which the quality control department has the following functions: -

1. Development of test procedures for measuring quality levels.
2. Development of sampling plans, as 100% inspection is often not feasible.
3. Establishment of specifications of raw materials, supplies, production processes and packages for finished products until they are consumed.
4. Recording and reporting results, which are transmitted promptly for the appropriate personnel for immediate action.

The functions of this department aims at assisting in taking necessary correlative steps to

maintain the quality of the manufactured products by locating and identifying the process faults in order to control the scrap and waste, achieving better utilization of raw materials and equipment assuring that the plants and packaged products are in compliance with food laws and regulations.

2.3 Impact of Official Controlling Bodies

This section will discuss the impact of controlling body as it affects Nigerian bottling company (NBC) Plc in as much as we want quality standard products, our environment should not be neglected as the waste product of the manufactured products make the ecosystem unsafe.

The two official bodies that visit Nigerian Bottling Company (NBC) Plc from time to time in order to monitor quality standard for Nigeria made product and its environmental degradation are Nigeria standard organization (NSO) and Federal Environmental Protection /Agency (FEPA) of which shall be discussed one after the other.

i. Nigeria **Standard Organization** (NSO): The Nigeria standard organization was established by a degree in 1971 to develop and monitor quality standards for Nigerian products. In Nigerian Bottling Company (NBC) Plc, the organization NSO ensures that specific qualities concerns are adhered to.

ii. **Federal** Environmental **Protection Agency** (FEPA): The concern of this body is the effect of production on the physical environment or the ecosystem. Usually, we think less about this, when we are considering production we must worry as much about the environment as worry about quality and standard of product pollution is obvious and inevitable by product of our effort to produce goods and services, the agency FEPA is geared towards checking and controlling the harmful effect and sometimes toxic by product.. They ensure with respect to the Nigerian Bottling Company (NBC), Plc, that waste product generated from the system does not have effect on physical environment. The existence o

such controlling bodies does not only help organization design but also implements elective quality managing system and control the amount of waste product generated in the system, but also accreditation of an organization under such standard provided assurance to customers.

2.4 The Production Process

The major. material used in the production of these soft drinks is water 87^{o}%, sugar 13%, carbon(iv)oxide and concentrate. These raw materials are examined and the bad ones are sorted and removed.

Water Treatment: Water used in the production of the soft drink is treated to confirm to standard of which batch system of water treatment is used.

First, we meter water inside the tank, add chemicals and allow settling. These chemicals namely lime, chlorine and ferrous are used to treat water, lime is used to reduce the hardness of water particles together, while chlorine is used to kill micro-organisms. After the addition of chemicals, we agitate the water for some time and allow staying for 6 hours.

Filteration: The water has to leave the reaction tank and filter through a remove any remaining suspended material. It goes carbon purifies to trap chlorine any' other particles that escaped sand filter, the water leaving the carbon filter, passes through polishing filter to remove the occasional particles of activated carbon and flakes of scale or rust which may break loose from the water lines.

Syrup Preparation: We have the simple syrup rank and final syrup tank. In simple syrup tank, we pour in required amount of sugar and water for agitation for 1hour. After we transfer into the final syrup tank at this stage, we add coke concentration which is in liquid form and is made up of part one and two, of which we first add pad one before pad two. Then allow the syrup to rest for two

hours. After which we send for bottling, where the treated water will come from water treatment plant and the syrup from the syrup tank will meet together at the flow mix, which will be blended together to give coke. From the mix chamber, it goes into carbon cooler where the carbon(iv) oxide will be added.

Bottle Washing: Before ever the soft drinks are bottled, the dirty empty battles will be put into washer where the bottles are washed. The washer has six compartments, where the bottles go into the pre-rinse and they are soaked with water at room temperature between 40-45^{O}c from the pre-rinses bottles, from there to warm water tank that rinses the caustic which is slippery and corrosive at a temperature of 45^{O}C. The bottles are then transferred to the rinse compartment at 25^{O}c the least operation. It should be noted that, the higher the temperature, the better the bottles are cleaned. If the temperature in any compartment is low, then the result of the clearing process may not be satisfactory.

Filling Machine: The soft-drink is transferred from the carbon cooler to the filling machine which has vein tubes that fit in the drink in the bottles and finally to the crowner for the corking. The coke is bottled cold in order to allow the carbon(iv)oxide to absorb and to avoid breakages. After the filling and the corking, the soft drink undergoes final inspection where some defection bottles of drink are removed. The non-defected drinks go into markets for maximum consumption.

2.4.1 Samples and Inspection Process

Many types of inspection/test are carried out in Nigerian Bottling Company because its quality maintenance-on process line inspections and fiijished product inspection.

On Process Line Inspection: This is conducted stage after stage, which aXer the filtration process, quality control test is being applied by resting for chlorine carry-over which is dangerous

to health. This is achieved by testing the water and checking its appearance. AÈer syrup preparatión, we are required to test for taste, appearance and sugar (brix).

The essence is to know whether they conform to standard and if not, we check for the cause in order to avoid waste after production. We also test for carbon(iv) oxide, making sure that the actual amount is added to the beverage öf which coke requires more carbon(iv)oxide. During the bottle washing, the temperature of washing caustic strength, washing age?t alignment of the washing sets water level and pressure are tested to avoid breakages. After bottle washing, we check for caustic carry over by using phenolphthalein indicator, if añer adding it into the bottle and there is no colour change, it indicates that the bottle is clean, otherwise it is diity.

Finished Product Inspection: This is the inspection conducted after prôduction, first is the microbial test, which is carried out to check the existence of micro-organisms which may be dangerous to the body. For this test, samples are taken from the bottling section and test conducted.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 INTRODUCTION

This study focusing on the application of Statistical Quality Control (SQC) techniques within the production processes of Seven-Up Bottling Company in Ibadan. The design allows for an in-depth examination of quality control practices, variability in the production process, and the effectiveness of existing quality assurance systems.

3.1 **Method of Data Analysis**

The data was firstly evaluated to verify the basic assumptions of statistical quality control these assumptions are:-

The normality assumption: - The normality assumption was tested using the Chi-square 'goodness of fit test, proposed by Pearson (1900), and also by graphical assessment of the histogram of the observations with associated normal curve. The test statistic for Chi-Square goodness of fit is given by

$$\chi^2 - \sum_{i=1}^{n} \frac{(0.i - Ej)^2}{Ei} - X^2_{k\,r\,1}$$

Where, O= observed frequency

E1 = Expected frequency

K = number of classes into which the whole data is subdivided

r = number of estimated parameters

The hypothesis to be tested is

Ho: The data is drawn from a normal population. Against, the alternative.

Hi: The data is not drawn a normal population

The decision rule is to reject the null hypothesis Ho. if at a level of significance, the Chi-square calculated from the data is greater than the Chi-Square tabulated with K-r 1 degrees of freedom Or, the plot of the histogram with its associated normal curve does not appear bell-shaped. Otherwise, do not reject Ho.

The next assumption to verify the basis of which the quality control is applied is that the data was randomly collected. This was done using the runs test. The observations were compared with the median. Observations above the median value is tagged "a" and observations below the median tagged "b", while values equal to the median were ignored.

The test statistic for randomness is given by

$$Z_c \quad \frac{V \quad \mu_v}{\delta v} \; N(0,1)$$

Where, V = number of runs

$$\mu_v = \frac{2N_1N_2}{N_1 + N_2} + 1$$

$$\delta v = \left[\frac{2N1/N(2\,N2 - N1 - N2)}{(N1+N2)^2\,(N1+N_2 - 1)}\right]^{1}_{2}$$

Where N_1 = number of a's

N_2= number of b's

a = the sample points above the median value

b = the sample points below the median value

The null hypothesis H_0 to be tested is that the data completely random. Against, the alternative H_1, the data is not completely random.

The decision rule is to reject the null hypothesis H_0, if at a level of significance, the values of Z_{cal} lies outside the interval $(-Z_{u/2}1Z_{u2})$, and not reject otherwise. Also, another assumption to verify is that the variances are constant over the period under consideration. The Bartlett's test of homogeneity of variance was applied to the data Bartlett's test statistic given by

$$X^2 = \frac{2.3026\ Q}{H} - X^2,(k-1)$$

$$\textit{Where, } H = 1 + 1 + \frac{1}{3(k-1)}\left(\sum_{I=1} \frac{1}{n_1-1} - \frac{1}{N-K}\right)$$

$$Q = (N — K) \log S^2p - \sum(n1 -1) \log S^2_1$$

$$S^2p = \frac{\sum (n1 - 1)S^2_1}{N — K}$$

n1 = The sample number

K = the number of sub-groups

N = the total number of observations

The null hypothesis H_0 to be tested is that the samples have constant variance. Against, the alternative hypothesis H_1. the samples have no constant variance.

Under the null hypothesis H_0. the Bartlett statistic follows the distribution with k -1, degrees of freedom. Therefore, the decision rule is to reject the null hypothesis No if $^2_{cal}$ is greater than the tabulated values X^2_{k-1} Or do not reject Ho otherwise.

The data on each of the four quality characteristics are such that the means and variances of the sub-groups can be calculated with these the process mean and process variability can be examined for statistical quality control.

The assessment of process stability is more elective if the standards are known. However, when the standards are not known, they can be estimated from the data available. The sample mean chart (X - chart) was used to examine the stability of the process mean of the data under consideration, the standards are not given and they are therefore estimated from the data.

If X_1, X_2,…X_k denote the means of the sub-groups and $R_1.R_{.2}$,..., R_k denote their corresponding ranges, then by distribution theory, it has been shown that $E(X_1) = \mu$.

Therefore, $\mu = X$, Var $(X_1) = \delta^2_0/n$

$E(R_1) = \delta_0 d_2$. Then $\delta_0 = R/_{d2}$

$Var(R_1) = \delta^2_0 d_3 = \delta_R$. Then $\delta_{R.} = \delta_0 d_3 = Rd_3/_{d2}$

Where, d_2 and d_3 are constants whose values depend on the size of sub- group n.

For the process mean ($\bar{\chi}$ - chart), the arithmetic mean $\bar{\chi} = n \sum_{i=1} \chi_i$ is the sub-group means for the control chart have the following

assumption:

1. Randomly selected
2. Normally distributed
3. No systematic variation
4. Variance constant and fixed at δ_0

If $\bar{X} \sim N(\mu. \delta_0)$, then $\bar{X} \sim N(\mu. \delta^2_0/n)$

About 68% of all observation lie within one standard (1 δ_0).

About 95% of all observation lie within two standards (2 δ_0), that is when the process is under control; about 95% of all observations are expected to lie within the warming limits.

About 99.7% of all observations lie within three standards (3 6), that is, almost all of the observations are expected to lie within the action limit. In order words, a process may be suspected to be out of statistical quality control if more than 0.3% of all observations fall outside the action limits.

For the process mean ($\bar{X}$- chart) using range (R)

Upper action limit = $\bar{X} + A_2\bar{R}$

Lower action limit = $\bar{X} - A_2\bar{R}$

Central line = $\bar{X}$

Upper action limit = $\bar{X} + {}^{2}/_{3}A_2\bar{R}$

Where, A2 is a constant whose value depends on the size of n sub-group.

For the process variability (R - chart)

Upper warming limit = $1 + {}^{1}/_{3}(D_4-D_4)\,\bar{R}$

Upper action limit $D_4\bar{R}$

Central line = $\bar{R}$.

Lower warning limit = $1-{}^{1}/_{3}(D_4- D_3)\bar{R}$

Lower action limit = $D_3\bar{R}$

Where, D_3 and D_4 are constants whose values depend on the sample size n.

CHAPTER FOUR

4.0 DATA PRESENTATION AND ANALYSIS

The data collected from 7UP Bottling Company is summarized below on the weight of bottles weight in grams for the month of April, 2025 from different machine represented by X_1, X_2, and X_3

4.1 DATA PRESENTATION

TABLE 1

Day	**Sample 1 (ml)**	**Sample 2 (ml)**	**Sample 3 (ml)**	**Mean (ml)**
1	502.3	499.6	501.9	501.4
2	499.4	498.3	498.4	498.3
3	504.4	499.3	500.2	499.6
4	500.3	498.2	499.1	500.3
5	498.4	500	499.3	499
6	503.3	499.7	499.1	499.1
7	501.7	502.7	502.7	501.8
8	498.1	503.5	497.3	500.5
9	502.9	502.4	504.5	504.2
10	497.2	495.7	503.1	499.8
11	504.4	498.4	497.6	500.3
12	501	500.3	502.9	500.2
13	503.8	499.1	492	498.9

14	499.1	494.2	499.9	500.2
15	501.4	499.2	498.3	499.7
16	500	503.4	502.3	501.1
17	498.5	502.8	505.1	501.8
18	498.9	498.9	501.7	500.8
19	495.7	503.6	503.9	500.5
20	503.7	500.9	497.9	501.9
21	495.9	497.7	502.6	499.8
22	501.6	495.8	499.9	499.5
23	496.8	501.4	499.3	500.2
24	499.8	503.1	499	499.5
25	500.2	496.6	501.1	500.6
26	503.2	500.9	500.8	501.5
27	498.5	500.2	506.9	500.4
28	495.2	497.3	499	499.3
29	500.1	498	506.4	500.1
30	500.6	497.6	499.7	500.4

Source: 7up Bottling Company

4.2 DATA ANALYSIS

NORMALITY ASSUMPTION

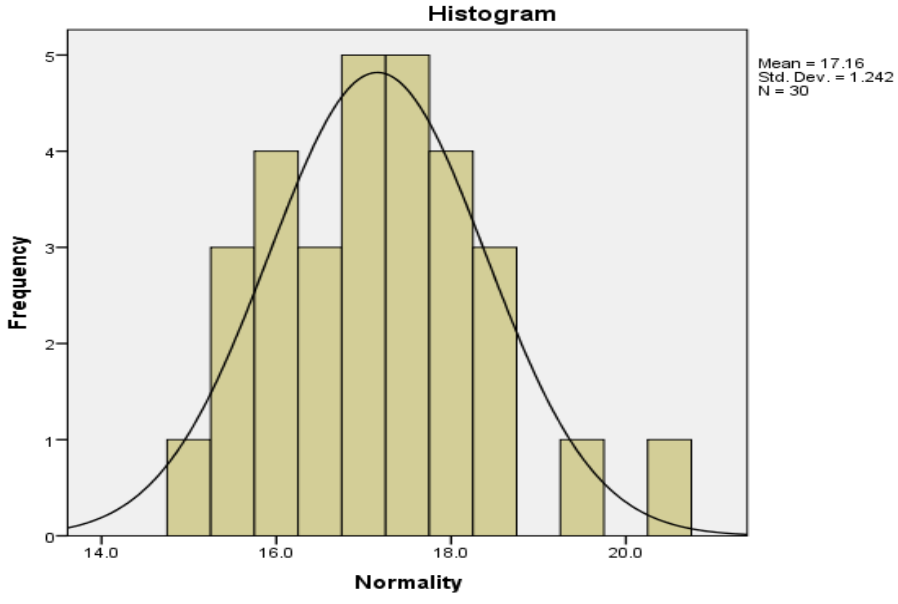

Figure 1: Normality plot of Bottle weight

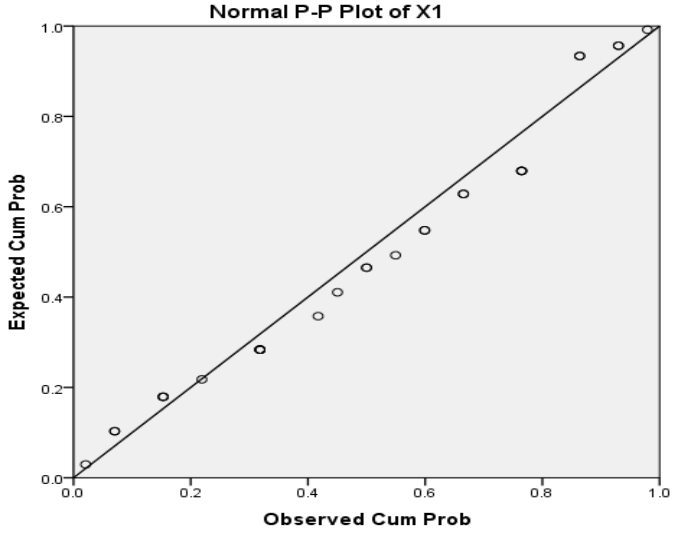

Figure 2: P-P plot of Bottle weight

Figure 1 and 2, the Graphical methods including the histogram and normal probability plot which are used to check the normality of the case study data and it implies that the data is normally independently identically distributed .Thus, it simply means that the sample data can be regarded as taken from a normal process.

Hence it is concluded that the observations in the data set are random. After validating the three critical assumptions, the process capability for the boring operation would be quantified.

CONSTRUCTION OF $\bar{X}$ AND *S* CHART

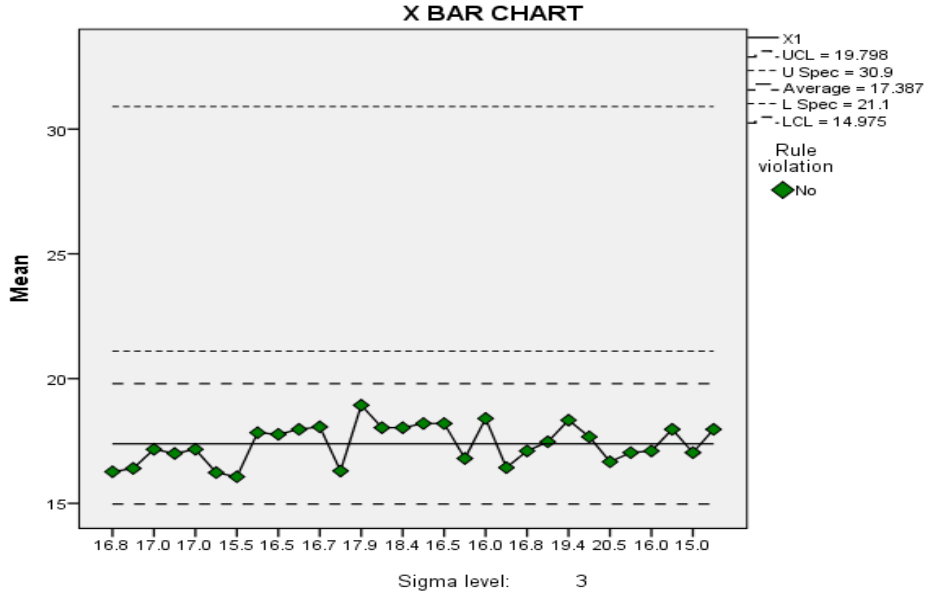

Figure 3: showing the X bar chart of Bottle weight

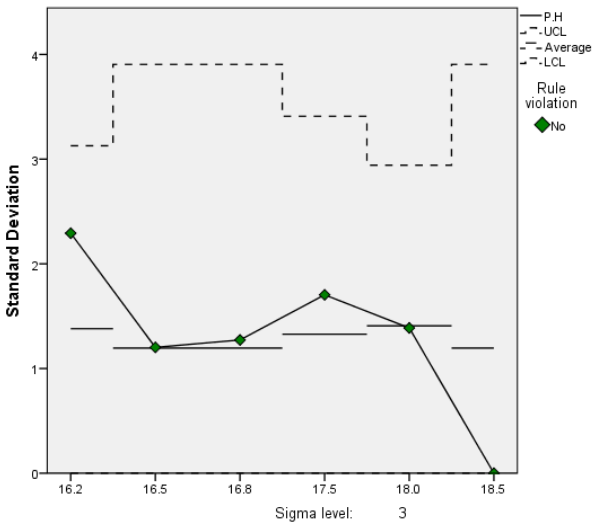

Figure 4: showing the S-chart of the weight of the bottle

From Figure 3 and Figure 4 above It shows that all plotted sample range and mean values are within the control limits on both S-Chart as well as $\overline{\boldsymbol{X}}$-Bar chart and no indication of Trend, shift, run and clustering has been noticed. Hence, it is concluded that the process is under statistical control and operating under the influence of only chance causes of variation.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY OF FINDINGS

Based on the data collected, the analysis carried out and the results obtained, it was observed that different machine produced different weight of the bottle daily.

For the test of Normality Assumption, the histogram and normal probability plot shows that the data is normally independently identically distributed since the histogram form a bell-shaped and the p-plot points are at random.

Also for X bar and S chart, it shows that all plotted sample range and mean values are staying in a statistical control since there is no point falling outside the upper and the lower class limit and no indication of Trend, Shift run and clustering has been noticed, Hence its concluded that the process is under statistical control and operating under the influence of only chance causes of variation.

5.2 CONCLUSION

In references to the data obtained, the analysis carried out and the results obtained, it was discovered that the data follow a normal distribution and we can also conclude that the X-bar and S-Chart are within control.

5.3 RECOMMENDATIONS

In order to achieve continuous improvement of the process, the bottling company should always attempt to redefined the voice of the process to match and then to surpass the expectation of the customer.

Also, the company specification limits should be redefined to be properly centered and to meet customer requirements.

The assignable cause of variation in the machine should be corrected. These errors may be changes in raw materials, incorrect processing, temperature or machine speeds, operator errors, or damage to equipment.

There should be a laboratory unit in every industry and they should increase the number of samples for statistical test.

The company should enhance job training for the workers operation in each department.

Finally, focuses should be made to reduce the proportion of product or services that does not meet specification, using measures such as percentage of non conforming product.

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