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Controlling Attributes in Production Using c and u Control Chart for Attributes

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Abstract:
This paper successfully showed how controlling attributes are useful in production process of a company. Many companies face the problem of non-conforming or rather defective items in production. But to minimize the problem of defective items faced by companies, control chart for attribute and data gotten from a selected company was used to analyse the data and all showed to be in control. Therefore, it is seen that control chart for attribute is a very useful tool in a production process because it helps producers to produce products that conforms to a set specification. As we all know a well-packaged product is said to be of best quality.

Keywords: *Quality, control, charts, defective, response, process, organization, inference, upper control limit, lower control limit*

1. Introduction

"The statistical control of quality is application of statistical principles and techniques in all stages of design, production, maintenance and service, directed towards the economic satisfaction of demand". The ISO standard defined quantity as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. Quality control is defined as the operational activities that are used to fulfil requirements for quality.

Statistical quality control (SQC) is the application of statistical methodology in quality control. Statistics is concerned with drawing inference from random sample. Hence with sampling and with evaluating samples in order to take adequate decisions on material, products, manufacturing process, organisation etc. Quality control is the use of techniques and activities that compare actual quality performance with goals and define appropriate action in response to any shortfall. It is the process that monitors specific projects results to determine if they comply with relevant standards and identifies different approaches to eliminate the cause for the unsatisfactory performance. There are a couple good tools that can be used to control quality on a product. But for this paper, the control charts for attributes will be used. Control charts is a graphical display of data that illustrates the results of a process over time, the purpose of a control chart is to determine whether a process is in control or out of control over a specified length of time.

2. Methodology

Secondary data were obtained from the production record from a selected water company. The method of analysis used is the control chart for attribute. Specifically, c and u control charts. There are two main categories of control charts, those that display attribute data and those that display variable data.

Attribute data refers specifically to category of control chart that displays data that result from counting the number of occurrences or items in a single category of similar items or occurrences. These "counts" data may be expressed as pass/fail, yes/no or presence/absence of a defects.

Variable data refers to the category of control chart that displays resulting from the measurement of a continuous variable. Example of variable data is elapsed time, temperature and radiation dose.

2.1. c-CHART

The c-chart also known as control chart for non-conformities. A nonconforming item is a unit of product that does not satisfy one more of the specification for that product. Each specific point at which a specification is not satisfied results in non-

conforming product. If no standard value of c is given, then c may be estimated as the observed average number of non-conformities in a preliminary sample of inspection units $\bar{C}$. Hence, the control chart has parameters defined as
Upper Control Limit (UCL) = $\bar{C} + 3\sqrt{\bar{C}}$,CL = $\bar{C}$ and the Lower Control Limit (LCL) = $\bar{C} - 3\sqrt{\bar{C}}$. Where $\bar{C} = \frac{\sum_{i=1}^{m} Ci}{m}$ and
Ci = number of the non-conformities in the ith sample.
m = number of observations

2.2. u-CHART

The u-chart, also known as control chart for defects per units is a type of control chart used to monitor count-type data where the sample size is greater than one, typically, the average number of non-conformities per unit.
The u-chart defers from the c-chart in that, it accounts for the possibility that the number or size of inspection units for which non-conformities are to be counted may vary. The u-chart shows the proportion of non-conforming units in subgroups of varying sizes. Non-conformities are defects or occurrences found in the sampled subgroup.
The control limits are described as:
Upper Control Limit (UCL) = $\bar{u} + 3\sqrt{\frac{\bar{\bar{u}}}{n}}$. Control Limit (CL) = $\bar{u}$ and the Lower Control Limit (LCL) = $\bar{u} - 3\sqrt{\frac{\bar{\bar{u}}}{n}}$ where $Ui = C/_n$ and
C = number of defects or non-conformities.
n = sample size
m = number of observation, and $\bar{u} = \frac{\sum_{i=1}^{m} ui}{m}$

2.3. Analysis

Thirty (30) batches of sachet water were selected from the company's production records. One (1) batch of sachet water equal 100 bags and 30 batches = 3000 bags. This implies batch inspection of checking every 100 bags of water produced.

Batch Number	Sample	Number of Defectives (In Bags)
1	100 Bags	12
2	100 Bags	7
3	100 Bags	5
4	100 Bags	4
5	100 Bags	3
6	100 Bags	5
7	100 Bags	9
8	100 Bags	10
9	100 Bags	14
10	100 Bags	6
11	100 Bags	7
12	100 Bags	2
13	100 Bags	6
14	100 Bags	10
15	100 Bags	8
16	100 Bags	6
17	100 Bags	3
18	100 Bags	1
19	100 Bags	4
20	100 Bags	7
21	100 Bags	6
22	100 Bags	14
23	100 Bags	0
24	100 Bags	9
25	100 Bags	5
26	100 Bags	7
27	100 Bags	4
28	100 Bags	5
29	100 Bags	7
30	100 Bags	12
Total	3,000 bags	198

Table 1: Shows the Number of Defectives Obtained from the Sampled Population of the Sachet Water

Batch Number	Sample	Number of Defectives (Per 5 Bags)
1	5 bags	7
2	5 bags	4
3	5 bags	11
4	5 bags	3
5	5 bags	6
6	5 bags	8
7	5 bags	10
8	5 bags	5
9	5 bags	2
10	5 bags	9
11	5 bags	1
12	5 bags	3
13	5 bags	6
14	5 bags	3
15	5 bags	8
16	5 bags	5
17	5 bags	4
18	5 bags	3
19	5 bags	5
20	5 bags	4
21	5 bags	10
22	5 bags	4
23	5 bags	6
24	5 bags	8
25	5 bags	6
26	5 bags	6
27	5 bags	5
28	5 bags	4
29	5 bags	12
30	5 bags	10
Total	150 bags	178

Table 2: Shows the Data for the Construction of the Chart for Number of Defectives Per Unit in Sample of 5 Bags of Sachet Water Produced

2.4. Analysis

Calculating, we have $\widehat{Pi} = \frac{Di}{n}$ and $\widehat{Ui} = \frac{Ci}{n}$ we arrived at table 3 below:

Batch Number	Sample (N)	Number of Defectives (in Bags) (Di)	Fraction Defectives ($\frac{Di}{n}$)
1	100 Bags	12	0.12
2	100 Bags	7	0.07
3	100 Bags	5	0.05
4	100 Bags	4	0.04
5	100 Bags	3	0.03
6	100 Bags	5	0.05
7	100 Bags	9	0.09
8	100 Bags	10	0.10
9	100 Bags	14	0.14
10	100 Bags	6	0.06
11	100 Bags	7	0.07
12	100 Bags	2	0.02
13	100 Bags	6	0.06
14	100 Bags	10	0.10
15	100 Bags	8	0.08

Batch Number	Sample (N)	Number of Defectives (in Bags) (Di)	Fraction Defectives ($\frac{Di}{n}$)
17	100 Bags	3	0.03
18	100 Bags	1	0.01
19	100 Bags	4	0.04
20	100 Bags	7	0.07
21	100 Bags	6	0.06
22	100 Bags	14	0.14
23	100 Bags	0	0.00
24	100 Bags	9	0.09
25	100 Bags	5	0.05
26	100 Bags	7	0.07
27	100 Bags	4	0.04
28	100 Bags	5	0.05
29	100 Bags	7	0.07
30	100 Bags	12	0.12
Total	3,000 bags	198	1.98

Table 3: Fraction Defectives for N = 100 Bags

Batch Number	Sample	Number of Defectives (Per 5 Bags)	Fraction Defectives($\frac{Ci}{n}$)
1	5 bags	7	1.4
2	5 bags	4	0.8
3	5 bags	11	2.2
4	5 bags	3	0.6
5	5 bags	6	1.2
6	5 bags	8	1.6
7	5 bags	10	2.0
8	5 bags	5	1.0
9	5 bags	2	0.4
10	5 bags	9	1.8
11	5 bags	1	0.2
12	5 bags	3	0.6
13	5 bags	6	1.2
14	5 bags	3	0.6
15	5 bags	8	1.6
16	5 bags	5	1.0
17	5 bags	4	0.8
18	5 bags	3	0.6
19	5 bags	5	1.0
20	5 bags	4	0.8
21	5 bags	10	2.0
22	5 bags	4	0.8
23	5 bags	6	1.2
24	5 bags	8	1.6
25	5 bags	6	1.2
26	5 bags	6	1.2
27	5 bags	5	1.0
28	5 bags	4	0.8
29	5 bags	12	2.4
30	5 bags	10	2.0
Total	150 bags	178	35.6

Table 4: Fraction Defectives for N = 5 Bags

2.5. c-Chart

The Upper Control Limit $(UCL) = \bar{c} + 3\sqrt{\bar{c}}$ with $\bar{c} = \sum_{i=1}^{m} \frac{ci}{m} = \frac{178}{30}$ implies that $\bar{c} = 5.9333 \approx 6, UCL = 13, Control\ Limit\ (CL) = 6$ and the $Lower\ Control\ Limit\ (LCL) = \bar{c} - 3\sqrt{\bar{c}} = -1.3484 = 0$

Since LCL is negative, LCL = 0. Therefore, UCL = 13, CL = 6, LCL = 0

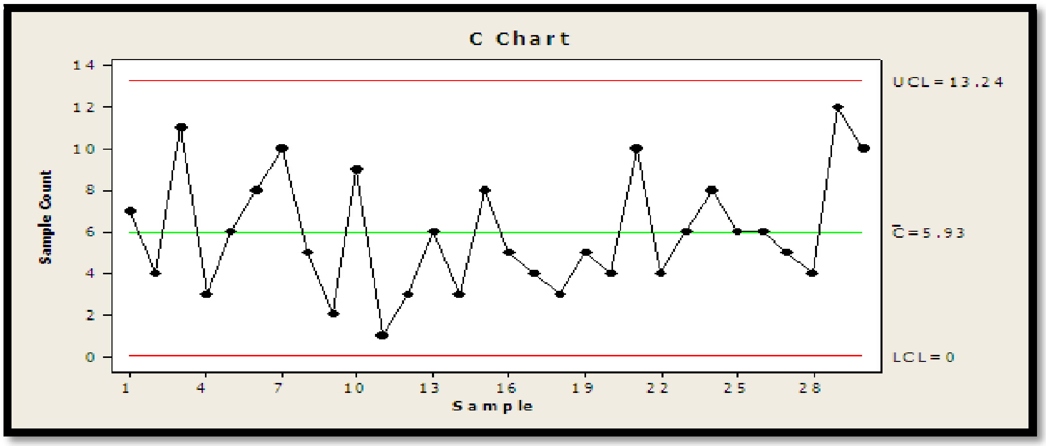

Figure 3: Control Chart for c-Chart

2.6. The u-Chart

The Upper Control Limit (UCL)for u is given as UCL $= \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}$ where

$\bar{u} = \sum_{i=1}^{m} \frac{ci/n}{m} = \frac{35.6}{30} = 1.1867 \approx 1.2.$

Upper Control Limit $= 2.7$, Control Limit $= \bar{u} = 1.2$ and Lower Control Limit (LCL) $= \bar{u} - 3\sqrt{\frac{\bar{u}}{n}} = -0.2697 = 0$

Since LCL is negative, LCL = 0. Therefore, UCL = 2.7, CL = 1.2, LCL = 0.

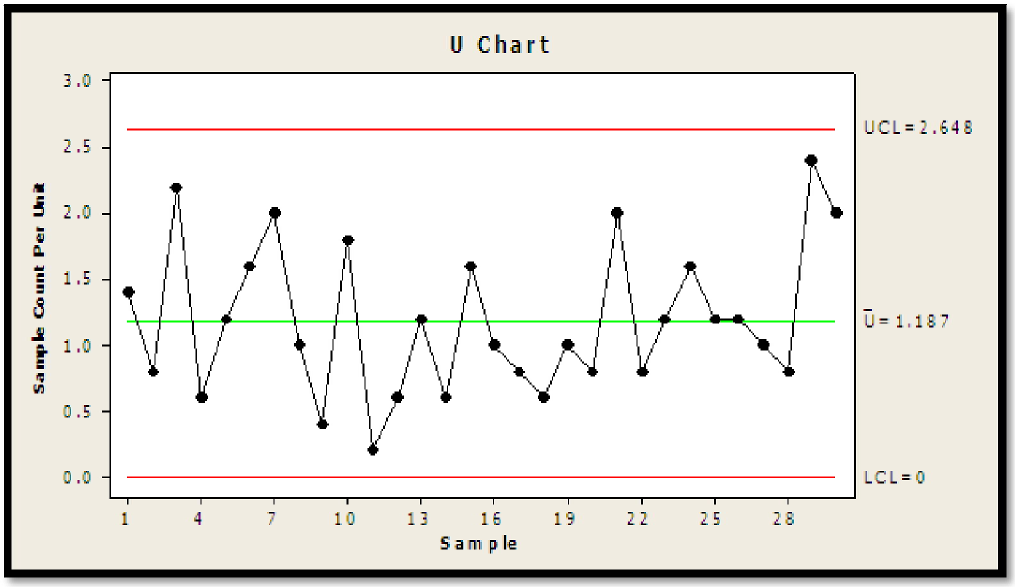

Figure 4: u Control chart

3. Result

From the analysis conducted and as presented in figures 1 & 2, we can easily see the graphical representation of the data for number of defects and defects per unit drawn. It is therefore evidently clear that the control chart or rather the process is in control. Because all sample points fall within the control limits

4. Conclusion

The purpose of this paper is to determine if the attitude of operators and management towards production affects the production process, to expose the researcher on how quality control is applied in manufacturing industries. All sampled points fall within the control limits, this paper also brought the attention of researchers on how quality control is applied in manufacturing industries to monitor process quality.

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