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ON SOME APPLICATION OF STATISTICAL QUALITY CONTROL TO INDUSTRIAL DATA

Odukoya Elijah Ayooluwa[1], Adediji Sulaiman[2], Korter Grace[3]

Department of Statistics, Faculty of Science, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria
Email: *ayooluwa88@gmail.com Nigeria*
Department of Statistics, Faculty of Applied Science, Federal Polytechnic Offa, Kwara State, Nigeria
Email:akinanalysis@gmail.com
Department of Statistics, Faculty of Applied Science, Federal Polytechnic Offa, Kwara State, Nigeria
Email:kortergrace@gmail.com

ABSTRACT

Quality controls have impact on the quality of the resulting product. The quality of the products produced by production is determined based on specific characteristics. Product standardization of an industry depends on its quality. Some problems are being encountered during production in the quality level of their products.

The aim of this Research is to examine the statistical quality control analysis on the production of paint. Specifically the study decided whether the production process is in control or out of statistical control, and also determined if the production variation is due to change courses or not, ascertained whether the product of good quality e.g. in size, weight, thickness, etc. produced optimal quality at reduced price and checked the variation during manufacturing. The quality control analysis on the production of paint from folly paint industry limited, Ibadan as the case study. Secondary data on the daily production of folly Oluyole extension paint industries for a period of 6 month which covers from January to June 2021 was collected. The data was presented in a tabular form whereas the control chart for number of defects per drum(c-chart), Control chart for fraction of defectives (p-chart) and X-chart was used to analyze the process. Conclusively, the finding of this research shows that C-chart and P-chart process was in state of statistical control or simply in control. Therefore, the finding has great commendation for the maintenance of the current statistical control practice in folly paint industries limited Ibadan. Hence, the product can be concluded to be good and not defective, also the little defect seen can be attributed to human error.

Keywords, Quality control-chart, p-chart, X-chart,C-chart

INTRODUCTION

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 by law, an institution, a coordinating body or a professional society. the quality control necessary to keep the product generated by the applicable quality standards. The company’s quality standards are usually dependent on raw materials, production process, and the finished product (results). Therefore, the activities of quality control can be done starting from the selection of materials, the production process up to the final result in the form of products and customized by the standards set in the company. Marilyn and Robert (2007) use control chart for attributes to monitor characteristics that have discrete values .Wiley *et al* (2007). Use quality characteristic to measure the shape of the distribution of the observed data. Marilyn and Robert (2007), set up control charts to monitor whether a process is in control does not guarantee process capability. Okorie 2016, used Statistical Quality Control in assessing the quality standard of Indigenous brewery Companies in Nigeria. David *et al.* (1998) stated that there is capacity for improvement of quality in the field of construction and author explained total quality management (TQM). Joe .*et al*. (1999) focused on the factors that create quality management problems for contractors in the infrastructure project. Karim *et al,* (2015). Study on ‘Statistical Quality Control of High-Resolution Winds of Different Radiosonde types for Chmatology Analysis, observed that quality control is among the most important steps in any data processing. Mahosh and Prabhuswany 2010 used Statistical Quality Control in carrying out a research on ‘Process Variability Reduction through Statistical Process Control for Quality Improvement. Goonatilake *et al.* (2011), used Statistical Quality Control in carrying out research on ‘Statistical Quality Control Approaches to Network Intrusion Detection.. BordeVukelic *et al,* (2008) used Statistical Quality Control to carry out a Development of a System for Statistical Quality Control of production Process, and observed that Statistical methods for quality evaluation provide analyses of production processes which can serve as the basis for undertaking adequate preventive and corrective measures in order to increase the total production quality.

Steps in Quality Control

1. Formulate quality policy.
2. Set the standards or specifications on the basis of customer's preference, cost and profit.
3. Select inspection plan and set up procedure for checking.
4. Detect deviations from set standards of specifications.
5. Take corrective actions or necessary changes to achieve standards.
6. Decide on salvage method i.e., to decide how the defective parts are disposed of, entire scrap or rework.

Statistical Quality Control

Statistical quality control refers to the use of statistical methods in the monitoring and maintaining the quality of products and services.
Statistical quality control is concerned with two control; which are:

1. Acceptance sampling
2. Control chart/Statistical process control

Acceptance Sampling: This is a statistical procedure used when a decision must be made to accept or reject a group of parts or items based on the quality found in a sample.
Control Chart: This is statistical procedure uses graphical displays known as control chart to determine whether processes should be continued or should be adjusted to achieve the desired quality

2.1 RESEARCH METHODOLOGY

The control limits for this chart type are

$$= \frac{\bar{P} \pm 3\sqrt{\bar{P}(1-P)}}{\bar{n}} \text{where } \bar{P} \text{ is}$$

The estimate of the long term process mean established during control – chart set up. Naturally, if the lower control limit is less than or equal to Zero, process observations only need be plotted against the upper control limit.
The proportion (P – chart) and the number detective chart (C – chart) are considered under the control chart for attribute while the mean chart ($\bar{x}$ - chart) is considered for the control chart for variable. The categories of control chart are used to determine the attribute and variability in the production process respectively.

POTENTIAL PITFALLS

I. Ensuring enough observations are taken for each sample
II. Accounting for differences in the number of observations from sample to sample.

ADEQUATE SAMPLE SIZE

Sampling requires some careful consideration, if the organization elects to use 100% inspection on a process, the production rate determines an appropriate sampling rate which in terms determines the sample size. If the organization elects to only inspect a fraction of units produced, the sample size should be chosen large enough so that the chance of finding at least one non-conforming unit in a sample is high – otherwise the false alarm rate is too high. One technique is to fix sample size so that there is a 50% chance of detecting a process shift of a given amount (for example, from 1% defective to 5% defective). If g is the size of the shift to detect, then the sample size should be set to.

$$n \geq \left(\frac{3}{8}\right)^2 \bar{P}(1-P)$$

Another technique is to choose the sample size large enough so that the P – chart has a positive lower control

Limit or $n > \frac{32(1-P)}{\bar{P}}$

SENSITIVITY OF CONTROL LIMITS

Some practitioners have pointed out that the P – chart is sensitive to the underlying assumptions, using control limit derived from the binomial distribution rather than from the observed sample variance. Due to this sensitivity to the underlying assumptions, P – chart are often implemented incorrectly, with control limits that are either to wide or too narrow, leading to incorrect decisions regarding process stability. A P – chart is a form of the individual chart (alsorefered to as "XMR" or "IMR") and these practitioners recommend the individual chart as a more robust alternative for count – based data.

Step 3: The $\bar{P}$is calculated

$$\bar{P} = \quad \sum_{i=1}^{n} p$$

Step 4: The standard error is calculated

$$\sqrt{p} = \frac{\bar{P}\ (1-p)}{n}$$

Step 5: The upper limit (UCL) and lowest control limit are place a t ± 3 standard error from the $\bar{P}$ respectively.
Step 6: The production is plotted against the proportion defective to defective whether the process is under control or not

Number defective Chart (C – chart)

This control chart is also used to determine the attributes of the product in process of production
Procedure

Step 1: The defective are identified from the data collected

Step 2: $\bar{c}$ is $\frac{Summation\ of\ Detective}{Sample\ size}$

Step 3: The standard error is determined

i.e. $\sqrt{p} = \sqrt{\bar{c}}$

Step 4: The upper and lower control limits are placed at ± 3 standard error from the $\bar{c}$ respectively.
Step 5: The upper production is plotted against the detective to determine whether the process is in – control or not

MEAN CHART ($\bar{X}$ CHART)
This control chart estimate the variability in the production process, it is a control chart for variable.

Procedure:
Step 1: The data is collected is considered in the sub – group from because data must be in sub groups for the construction of ($\bar{X}$ chart)
Step 2: The mean of each group is determined

$$\bar{X}\ \frac{\int_{i=1}^{n} xi}{n}$$

Step 3: The mean of means for all the sub – group determine $\bar{X}\ \frac{\int_{i=1}^{n} xi}{k}$
Step 4: The standard error is determined

$$\iint_{a=1}^{k} \frac{(\bar{X}\ -\ \bar{X}\ )}{k}$$

Step 5: The upper limit (UCL) and lower limit (LCL) are placed at ± 3 standard error from the $\bar{X}$
Step 6: The subgroups are plotted against the means to determine whether the production process varies from each other.
But in many business situation, we are also with the quality of income finished products suppose we want to decide whether to accept or reject a group of items on the basis of specific quality characteristics, the groups called lot in quality control and statistical method that allows us to base the accept or reject decision on the inspection of sample of items from the lot is called Acceptance Sampling.

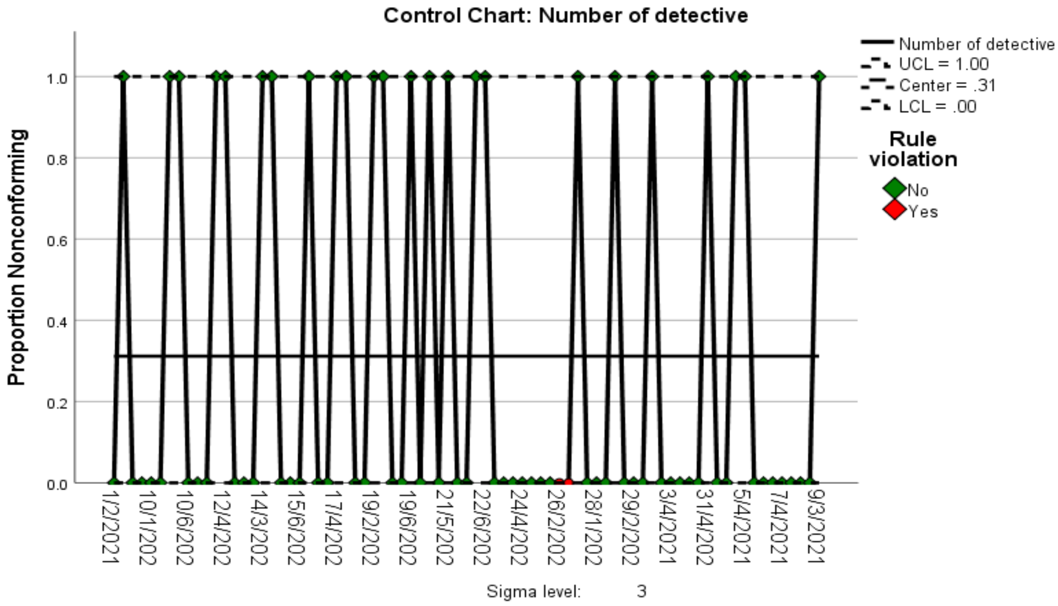
DATA PRESENTATION AND ANALYSIS

The analysis and interpretation of Data collection for this research work. The research used graphical to detect whether the pattern of the products of Folly Paint Industries Limited is in control or out of control. How every out of many statistical controls, X bar, C – chart and P – Chart are employed.

Serial No.	**Date**	**Quantity Produced**	**Number of detective**
1.	3/1/21	200	5
2.	5/1/21	200	3
3.	7/1/21	200	3
4.	10/1/21	200	3
5.	12/1/21	200	3

6.	14/1/21	200	3
7.	17/1/21	200	6
8.	19/1/21	200	3
9.	21/1/21	200	1
10	24/1/21	200	0
11.	26/1/21	195	4
12.	28/1/21	200	3
13.	1/2/21	220	4
14.	3/2/21	220	4
15.	5/2/21	220	4
16.	8/2/21	220	3
17.	10/2/21	200	3
18.	12/2/21	200	3
19.	15/2/21	200	2
20.	17/2/21	200	2
21.	19/2/21	200	5
22.	22/2/21	200	3
23.	24/2/21	200	2
24.	26/2/21	200	3
25.	29/2/21	200	4
26.	31/2/21	200	6
27.	1/3/21	250	5
28.	5/3/21	250	5
29.	9/3/21	250	5
30.	12/3/21	250	5
31.	14/3/21	250	5
32.	16/3/21	250	5
33.	19/3/21	200	5
34.	21/3/21	200	5
35.	23/3/21	200	3
36.	28/3/21	200	3
37.	1/4/21	200	3
38.	3/4/21	350	10
39.	5/4/21	350	5
40.	7/4/21	350	10
41.	10/4/21	350	5

42.	12/4/21	350	5
42.	14/4/21	350	5
44.	17/4/21	350	5
45.	19/4/21	300	10
46.	21/4/21	300	10
47.	22/4/21	300	10
48.	24/4/21	300	10
49.	27/4/21	350	5
50.	28/4/21	350	5
51.	31/4/21	350	5
52	5/5/21	200	2
53	7/5/21	200	0
54	10/5/21	200	5
55	12/5/21	200	3
56	14/5/21	200	4
57	17/5/21	200	5
58	19/5/21	200	2
59	21/5/21	200	5
60	22/5/21	200	5
61	24/5/21	200	6
62	27/5/21	195	0
63	28/5/21	200	2
64	30/5/21	220	3
65	1/6/21	220	3
66	3/6/21	220	3
67	5/6/21	220	2
68	8/6/21	200	2
69	10/6/21	200	2
70	12/6/21	200	1
71	15/6/21	200	1
72	17/6/21	200	1
73	19/6/21	200	5
74	22/6/21	200	5
75	24/6/21	200	4
76	26/6/21	250	2
77	29/6/21	200	3



P-char

$$\bar{P} = \frac{Sum\ Proportion\ of\ Defective}{Sample\ Number}$$

$\bar{P}$=1.31148/77

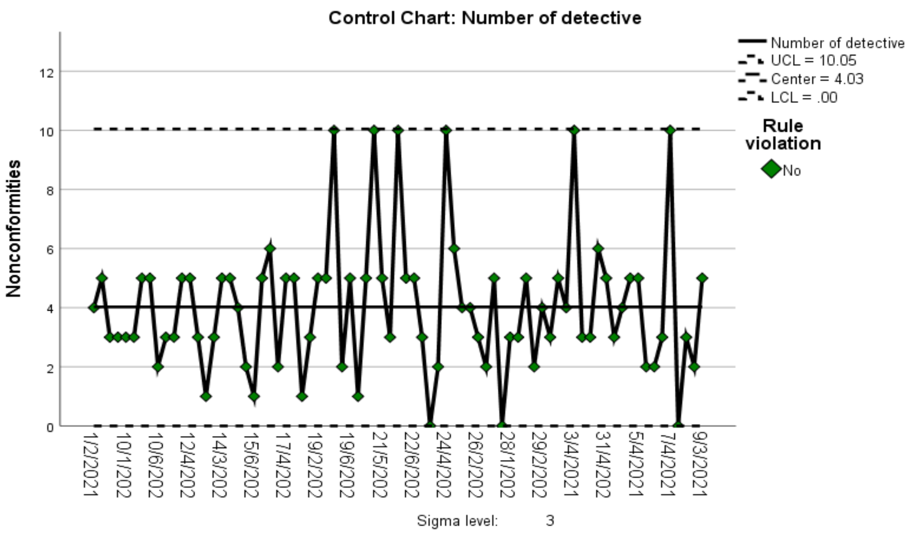
$\bar{P}$ = 0.0173

Controllimit;

$$= \frac{\bar{P} \pm 3\sqrt{\bar{P}(1-P)}}{\bar{n}}$$

UCL = 1.00

LCL = 0.00**C-chart**



The C-chart above tells that the process is perfectly under control as no point is seen to be violating the control rule.

$$\sum defective\ item\ = 310$$

$$\bar{C} = \frac{Sum\ of\ Defects}{Numbers\ of\ Samples}$$

$\bar{C}$= 310/77

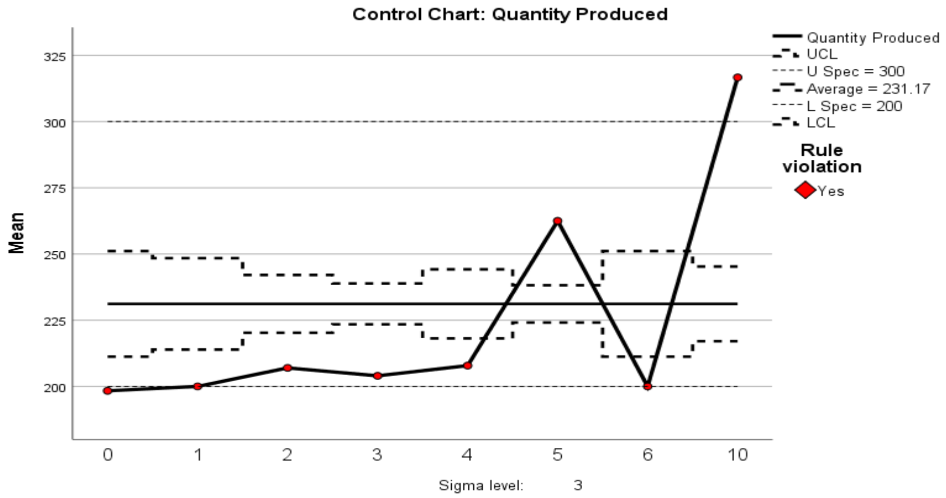
C = 4.03

UCL = $\bar{C} + \sqrt[3]{\bar{C}}$

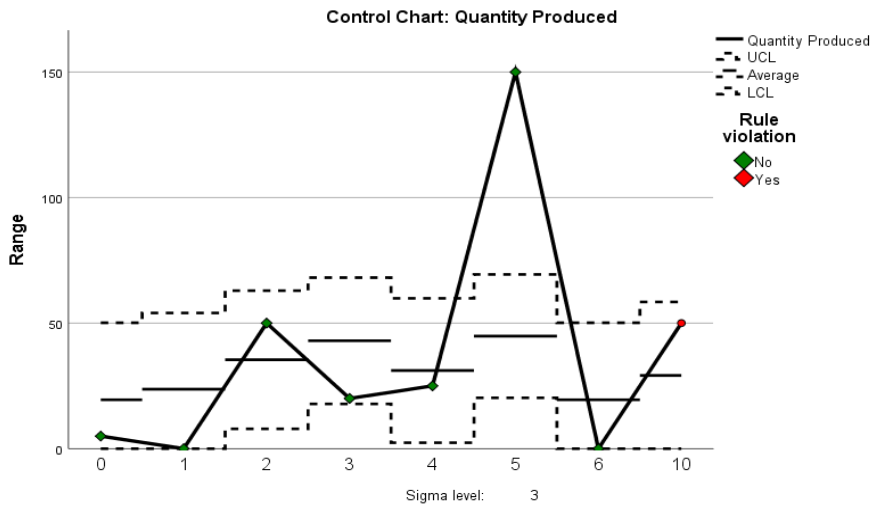
UCL= 10.05

LCL = 0.00

X-chart



X = 231.17
UCL = 300
LCL = 200



The X-chart suggest that the number of points violating the control rule is only 8 out of 77 points in total then, the process can be said to be under control. Hence, the product can be concluded to be good and not defective. Also, the little defect seen can be attributed to random error.

SUMMARY

The study examined the statistical quality control analysis on the production of paint. Specifically the study decided whether the production process is in control or out of statistical control; determined if the production variation is due to change courses or not; ascertained whether the product of good quality e.g. in size, weight, thickness, etc; produced optimal quality at reduced price and checked the variation during manufacturing.

CONCLUTION

It was discovered from graphical illustration that the product process of Folly paint industries is in control. IT revealed that the variation exists in the production is due to chance causes, which cannot be explained in this research work. Hence, the researcher subjects the paper to further scientific investigation.

RECOMMENDATION

Based on the conclusion arrived at, the following measures are therefore recommended

I. That the control measures adopted by the company under the study are tentative because things are changing every seconds and the company try as much as possible to meet the customer need.

II. That the customers should not worry about the production process of the paint industries.

III. That the industries still meets the requirement for future sustainability

IV. That this research work should be subjected in the further scientific investigation

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