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Statistical Quality Control in Paint Manufacturing Company

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Abstract:*Attempt was made in this research work to ascertain the impacts of statistical process control in industries. It delved proper into finding out whether some companies make use of statistics process control using three different paint manufacturing companies. The Mean and Range Process control charts for the three companies showed that the production process/activities within the months under investigation are under control. Hence, there is no cause for alarm but a proactive action is needed to avoid exacerbated future occurrence. Process Statistics showed that the paints produced within the months under investigation for the three companies are not within customers specified limit/Standard. It was obvious that some companies have no active quality control department. The three companies were advised to redesign their system to monitor production process so as to meet customers demand and avoid assignable cause of variation.*
Keywords;*Variation, Control chart, Process control, Product control.*

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I. Chapter One

1.0 Introduction

The purpose of any manufacturing industry is to maximize profit and also to reduce or minimize cost. Such profit maximization industries aim at making efficient use of available resources in producing quality products or goods for their customers.

In other to avoid going out of business, they must try and protect the interest of their customers who are part of the determining factors for the survival of the industry.

A process that is stable but operating outside of desired limit (eg scrap rate may be in statistical control but above desired limit) needs to be improved through a deliberate effort to understand the cost of current performance I fundamentally improved the process.

SPC is used to monitor the consistency of processes used to manufacture a product as designed. It aims to get and keep processes under control. No matter how good or dad the design, SPC can ensure that the product or service is being produced as designed intended. Thus SPC will not improve a poorly designed product reliability, but can be used to maintain the consistency of how the product is, made and, therefore, of the manufactured product itself and it's as designed reliability.

Marilyn and Robert (2007),says the foundation for statistical process control techniques as quality control tool was led by Dr Walter Shewart who worked at the bell telephone laboratories in the 1920s when conducting research on method to improve quality and lower costs.

Quality as a concept has been defined 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 standard may be defined by law, an institution, a coordination body or a profession society.

According to Akinola (2009), Quality is the ability or degree with which a product, service, or phenomenon conforms, to an established standard, and which make 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. Chadra(2001), says quality can be defined in many ways, ranging from ''satisfying customers requirement'' 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.

Quality and its management played a crucial role in human history.According to Payam andReza (2009), the industrial revolution began in the United Kingdom during the 18th century and then extended to other countries.

Quality has become harder to manage due to mass production. Mass production was achievable by the division of labor and the use of machinery. In such a production line, workers performed repetitive tasks in a cooperative way using machinery. Division of labor for mass production also took away the pride of workmanship. Hence quality suffered in the production line and quality monitoring became an essential activity.

Listed below are different types of control chart ;

i D – chart (mean)
ii R – chart (range)
iii P – chart (proportion defective)
iv C – (defective per unit)

The study is essentially looking into the production process of manufacturing in industries. Using paints manufacturing industry.The probability basis of statistical quality control includes: sample mean, proportion defective, number of defect in production.

The quality control of product can be achieved in many ways which may be carried out:
before production, during production, and after production

Uses Of Statistics In Industry

1. It helps to identify the assignable causes of variation
2. It helps to save loses which the producer may have incured due to no maintenance of pre – determined quality control level.
3. It helps to create quality consciousness to both the producers and the consumer.
4. Statistics equipped management operators with relevant information on the general performance of industry.

This work is restricted to using statistical quality control techniques on the product of 3 paints and chemical companies in Nigeria. It also covers the use of the above named techniques in drawing reference and hypothesis after analysis on the production/manufacturing process.

Theaim of this study is to know if the companies do apply statistical quality control,find out whether the manufactured products (paints) within the period under investigation are under control using process control chart, find out whether the manufactured products are within customer's specified limit/standard,and to ascertain the proportion of defectives in the manufactured paints using proportion defective chart.

Thisstudy will create awareness on the application of statistical quality control in any production process and why one should always insist on quality and not price.

II. Chapter Two

2.1 Methodology

The basic steps and formula used in construction control chart for variable are as follow according to Gupta (2011),:

i. The use of mean,$\bar{Y}$chart: the steps are
   a. Select a random sample of size 'n' items for the manufacturing process and take measurement, thus y_1, y_2, y_3 ----y_n
   b. Compute the sample mean, the samples are
      $\bar{y}_1, \bar{y}_2, \bar{y}_3$ ---$\bar{y}_n$(that is $\bar{Y} = \sum_{i=1}^{n} Y = y_1+y_2+y_3\ldots+y_n$
   c. compute the mean of these sample called the ground mean.
      $(\bar{Y})$ = Σ of the mean of sub grounds
      Number of sample mean

The above computation of the mean will result to the central line (CL) which represents the average value of the quality characteristics of the means measurements corresponding to the control state.

d. compute the lower and upper control limit for the main denoted as:

UCL $\bar{Y}+\bar{Y}$ + $\bar{A}R$ and $\bar{L}$CL $\bar{Y}$-A_2R

Note; LCLy and UCLy: represent the control limit of both the lower and upper limit when plotted on a control charts.

ii. The use of range (R) charts: the control chart for range is: [note range is the different between the highest value and the lowest value (i.e max-min)].

Therefore, R= maximum- minimum for the average value denoted as

CL_RandUCL_R = D4R

$UCL_R$and UCL_R = D3R

Where D4 and D3 represent the constants measured parameter.

Definition Of Formulas

The following will be defined ;

a. The mean of means ($\bar{\bar{Y}}$)
b. The range R
c. The range and lower control limit

The mean of the means is the control limit

d. $\bar{\bar{Y}} = \frac{\Sigma Y_i}{n}$

The R

$\bar{R} = \frac{\Sigma R_i}{n}$

The lower and upper control limit are calculated using the A_2 table for (n=3 and A_2=1.02)

$UCL=\bar{\bar{Y}}+A_2\bar{R}$

$LCL= \bar{\bar{Y}}-A_2\bar{R}$

To be able to draw the range chart, the computation of the following is necessary.

a. The range.
b. The D_3 and D_4.

The range has been computed to be 3. The D_3 and $D_4$for n=3, is 0 and 2.57respectively. those will enable to calculate the upper and lower control imit.

The upper limit is computed as follows:

$UCL=D_4\bar{R}$

$LCL=D_3\bar{R}$

There are basically two types of data: primary and secondary data.However, in this research work, the research made use of secondary data because it provides and covers the information required from 2012-2017 quality control department of 3 different paints industries in Nigeria.

III. Chapter Three

Data Presentation And Analysis

3.1 Quality Control Chart

Table1: Data Presentation For Paintmanufacturing Company1:

Sample No.	January Y_1	June Y_2	October Y_3
1	0.69	0.34	0.40
2	0.3	0.35	0.23
3	0.56	0.24	0.64
4	0.52	0.72	0.4
5	0.50	0.2	0.68
6	0.50	0.33	0.63
7	0.58	0.18	0.42
8	0.4	0.53	0.08
9	0.31	0.15	0.07
10	0.80	0.5	0.02
11	0.7	0.6	0.04
12	0.04	0.5	0.15
13	0.7	0.5	0.13
14	0.07	0.4	0.8
15	0.64	0.7	0.3

Table 2: Data Presentation For Paintmanufacturingcompany 2:

Sample No.	February y_1	June y_2	October y_3
1	0.04	0.13	0.12
2	0.18	0.19	0.104
3	0.13	0.08	0.12
4	0.05	0.72	0.04
5	0.6	0.04	0.05
6	0.06	0.04	0.046
7	0.06	0.08	0.04
8	0.06	0.05	0.08
9	0.37	0.04	0.08
10	0.35	0.29	0.05
11	0.7	0.05	0.05
12	0.04	0.08	0.04
13	0.4	0.5	0.3

14	0.7	0.6	0.4
15	0,1	0.3	0.4

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Table3:Data Presentation For Paintmanufacturing Company3

Sample No.	February y_1	June y_2	October y_3
1	0.58	0.17	0.43
2	0.8	0.4	0.07
3	0.3	0.23	0.35
4	0.6	0.25	0.58
5	0.79	0.34	0.3
6	0.4	0.72	0.52
7	0.7	0.65	0.3
8	0.04	0.15	0.14
9	0.6	0.5	0.02
10	0.56	0.65	0.24
11	0.06	0.63	0.43
12	0.29	0.13	0.07
13	0.34	0.08	0.12
14	0.26	0.04	0.15
15	0.09	0.20	0.67

The data analysis will be done in line with the research questions:

Research Question One

Are the manufactured products within the period under investigation under control?

Table 4:Measurements For Finding Average And Range Of Paintmanufacturing Company One

Sample No.	February Y_1	June Y_2	October Y_3	Average $\bar{Y}$	Range $\overline{R}$
1	0.69	0.34	0.40	0.477	0.35
2	0.3	0.35	0.23	0.29	0.12
3	0.56	0.24	0.64	0.48	0.4
4	0.52	0.72	0.4	0.55	0.32
5	0.50	0.2	0.68	0.47	0.44
6	0.50	0.33	0.63	0.49	0.30
7	0.58	0.18	0.42	0.39	0.40
8	0.4	0.53	0.08	0.34	0.45
9	0.31	0.15	0.07	0.18	0.24
10	0.80	0.5	0.02	0.2	0.48
11	0.7	0.6	0.04	0.45	0.66
12	0.04	0.5	0.15	0.23	0.46
13	0.7	0.5	0.13	0.44	0.57
14	0.07	0.4	0.8	0.42	0.73
15	0.64	0.7	0.3	0.55	0.04
∑				5.957	6.32

Mean $\bar{Y}=\frac{\sum Y_i}{n}=\frac{5.957}{15}=0.397$

Range R$=\frac{\sum R_i}{n}=\frac{6.32}{15}=0.421$

To compute the lower and upper

UCL $Y = Y+A_2R$

$= 0.397 + 0.02\ (0.421)$

$= 0.826.$

LCL $Y = Y - A_2R$

$= 0.397 – 1.02\ (0.421)$

$= - 0.032$

Range

UCL $R = D_4R$

$= 2.57 \text{ X } 0.421$

$= 1.08197$

LCL $R = D_3R$

= 0 X 0.421
= 0.

Process Control Measurement for paint manufacturing company one using SPSS 20.1

Fig. 1: The Mean Control Chart of paint manufacturingCompany one

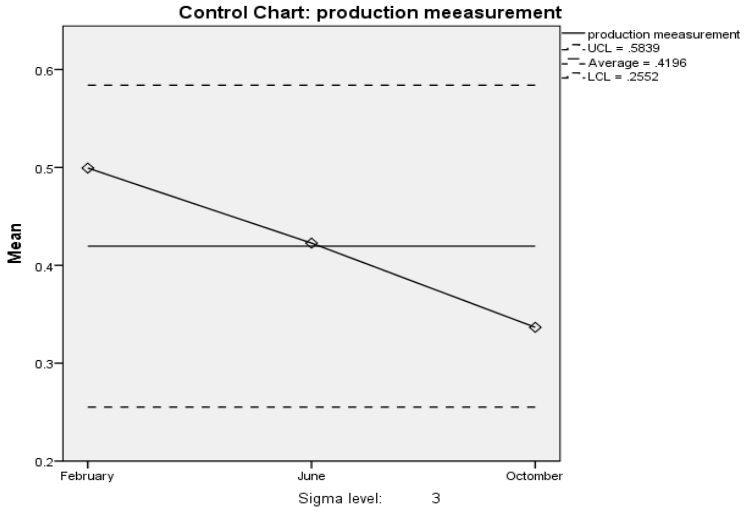
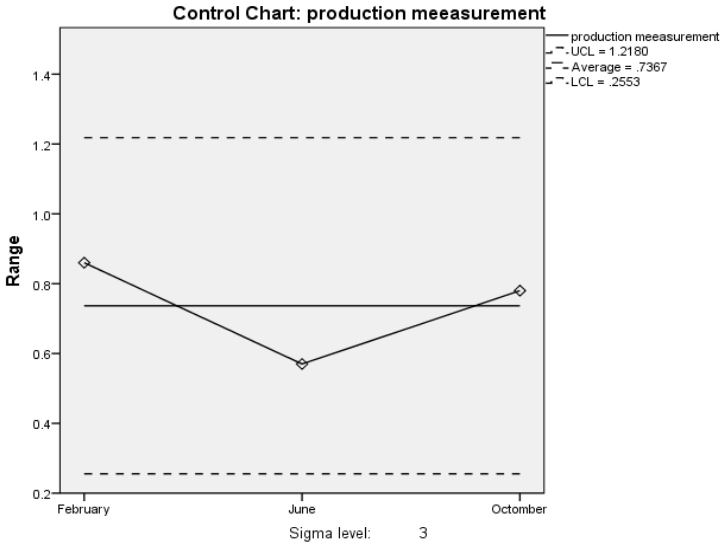


Fig. 2: The Range Control Chart For paint manufacturing company one



Interpretation of Result: The X-bar and Range Process control charts on fig 2 shows that the production process/activities within the months under investigation are under control. Hence there is no cause for alarm.

Table 5:Measurements For Finding Average And Range Of Paintmanufacturing Companytwo.

Sample No.	February y_1	June y_2	October y_3	Average $\bar{Y}$	Range $\overline{R}$
1	0.04	0.13	0.12	0.097	0.09
2	0.18	0.19	0.104	0.158	0.086
3	0.13	0.08	0.12	0.11	0.05
4	0.05	0.72	0.04	0.27	0.68
5	0.6	0.04	0.05	0.23	0.56
6	0.06	0.04	0.046	0.049	0.02
7	0.06	0.08	0.04	0.06	0.04
8	0.06	0.05	0.08	0.067	0.04
9	0.37	0.04	0.08	0.163	0.33

10	0.35	0.29	0.05	0.23	0.3
11	0.7	0.05	0.05	0.29	0.2
12	0.04	0.08	0.04	0.053	0.04
13	0.4	0.5	0.3	0.4	0.2
14	0.7	0.6	0.4	0.57	0.3
15	0,1	0.3	0.4	0.27	0.3
∑				3.419	3.236

Mean $\bar{Y}=\frac{\sum Y_i}{n}=\frac{3.419}{15}=0.2279$

Range R$=\frac{\sum R_i}{n}=\frac{3.236}{15}=0.2157$

To compute the lower and upper control limit

UCL Y = $Y+A_2R$

= 0.2279 + 1.02 (0.2157)

= 0.448.

LCL Y = $Y - A_2R$

= 0.2279 – 1.02 (0.2157)

= - 0.008.

Range

UCL R = D_4R

= 2.57 X 0.2157

= 0.55.

LCL R = D_3R

= 0 X 0.215

= 0.

Process Control Measurement of paint manufacturing company two using SPSS 20.1

Fig. 3: The Mean Control Chart of paint manufacturing company two

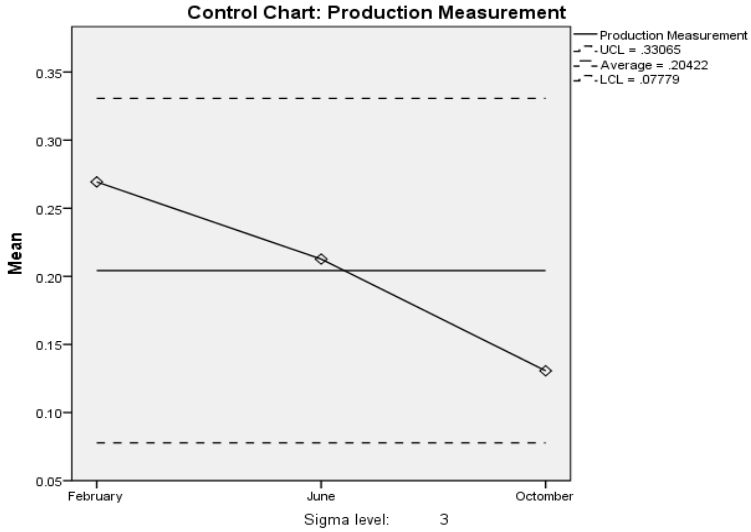
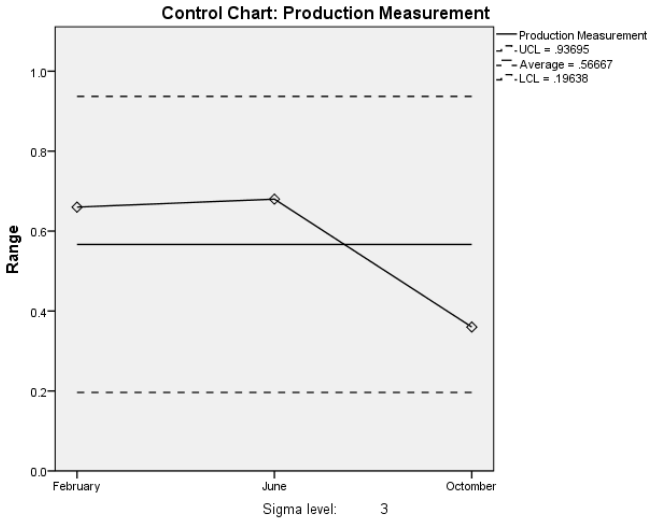


Fig. 4: The Range Control Chart ofpaint manufacturing company two



Interpretation of Result:
The X-bar and Range Process control charts on table 3 and 4 shows that the production process/activities within the months under investigation are under control. Hence, there is no cause for alarm.

Table 6: Measurements For Finding Average And Range Of For Paintmanufacturing Company Three

Sample No.	February y_1	June y_2	October y_3	Average $\bar{Y}$	Range $\overline{R}$
1	0.58	0.17	0.43	0.40	0.41
2	0.8	0.4	0.07	0.42	0.73
3	0.3	0.23	0.35	0.30	0.12
4	0.6	0.25	0.58	0.47	0.35
5	0.79	0.34	0.3	0.48	0.49
6	0.4	0.72	0.52	0.55	0.32
7	0.7	0.65	0.3	0.55	0.4
8	0.04	0.15	0.14	0.23	0.26
9	0.6	0.5	0.02	0.37	0.58
10	0.56	0.65	0.24	0.48	0.41
11	0.06	0.63	0.43	0.55	0.2
12	0.29	0.13	0.07	0.16	0.22
13	0.34	0.08	0.12	0.18	0.26
14	0.26	0.04	0.15	0.15	0.22
15	0.09	0.20	0.67	0.32	0.58
∑				5.61	5.55

For our mean $\bar{Y}=\frac{\sum Y_i}{n}=\frac{5.61}{15}=0.374$

For our Range $\mathbf{R}=\frac{\sum R_i}{n}=\frac{5.55}{15}=0.37$

To compute the lower and upper control limit

UCL $Y = Y+A_2R$
$= 0.374 + 1.02\ (0.37)$
$= 0.7514$

LCL $Y = Y - A_2R$
$= 0.374 – 1.02\ (0.37)$
$= 0.0034$

For Range

UCL $R = D_4R$
$= 2.57 \times 0.37$
$= 0.9509$

LCL $R = D_3R$
$= 0 \times 0.37 = 0$

Process statistics ofpaint manufacturing company threeusing SPSS 20.1

Fig. 5: The Mean Control Chart of of paint manufacturing company three.

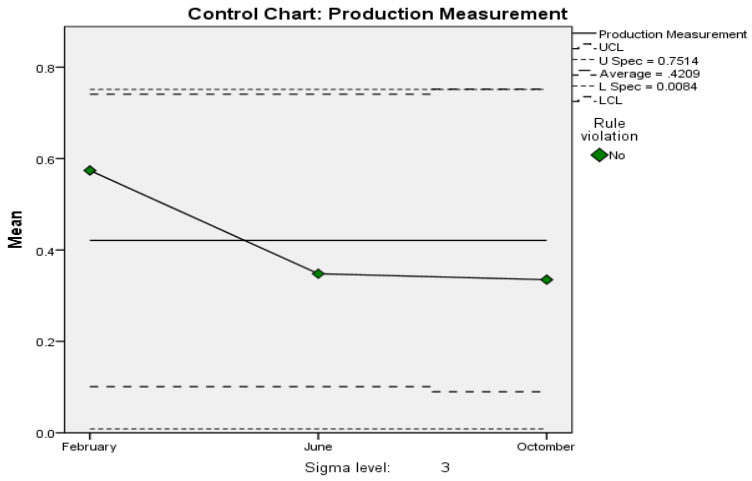
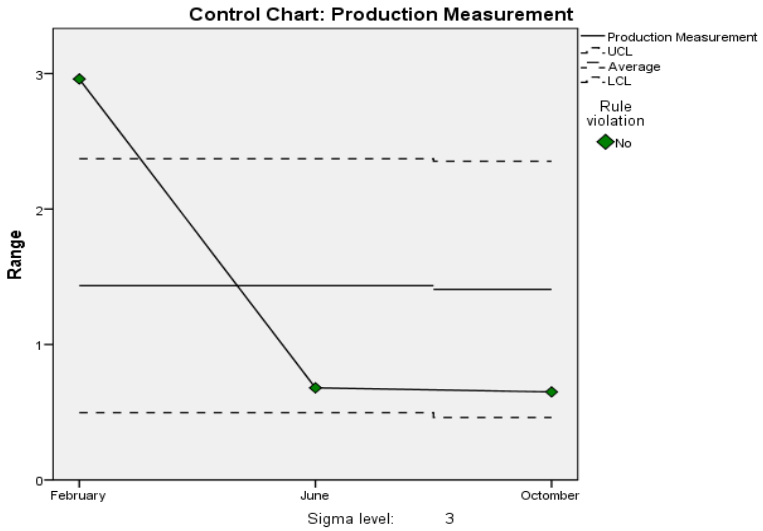


Fig. 6: The range Control Chart of of paint manufacturing company three.



Interpretation of Result:

The X-bar Process control charts on table 1 shows that the production process/activities within the months under investigation are under control. Although, the Range chart confirmed this in a clearer sense as the process was out of control on the month of January. The production activities of the month of January, needs thorough investigation. Hence there is no cause for alarm but a proactive action is needed to avoid exacerbated future occurrence.

Research Question Two

Are the manufactured products within customer's specified limit/standard?

Table 7:Process Statistics Forpaint manufacturing company one

Capability Indices	CP[a]	.280
	CpU[a]	.253
	CpK[a]	.253

The normal distribution is assumed. LSL = 0.225 and USL = 0.5809.

a. The estimated capability sigma is based on the mean of the sample group ranges.

Interpretation of Result:

From table 7,ie the process Statistics table, the value of CP=0.280 indicates that 28.0% of the paints produced within the months under investigation are within customers specified limit/standard. The value of CPK=0.253 shows that paint manufacturing company one is 25.3% centered at meeting customers **need.**

Table 8:Process Statistics For paint manufacturing company two

Capability Indices	CP[a]	.258
	CpU[a]	.258
	CpK[a]	.258

The normal distribution is assumed. LSL = 0.0777 and USL = 0.3305.
a. The estimated capability sigma is based on the mean of the sample group ranges.

Interpretation of Result:
From table 8,the value of CP=0.258indicates that 25.8% of the paints produced within the months under investigation are within customers specified limit Standard. The value of CPK=0.258shows thatpaint manufacturing company twois 25.8% centered at meeting customers need.

Table 9:Process Statistics for paint manufacturing company three

Process Statistics

Capability Indices	CP[a]	.299
	CpL[a]	.333
	CpU[a]	.266
	CpK[a]	.266

The normal distribution is assumed. LSL = 0.008 and USL = 0.75.

a. The estimated capability sigma is based on the mean of the sample group ranges.

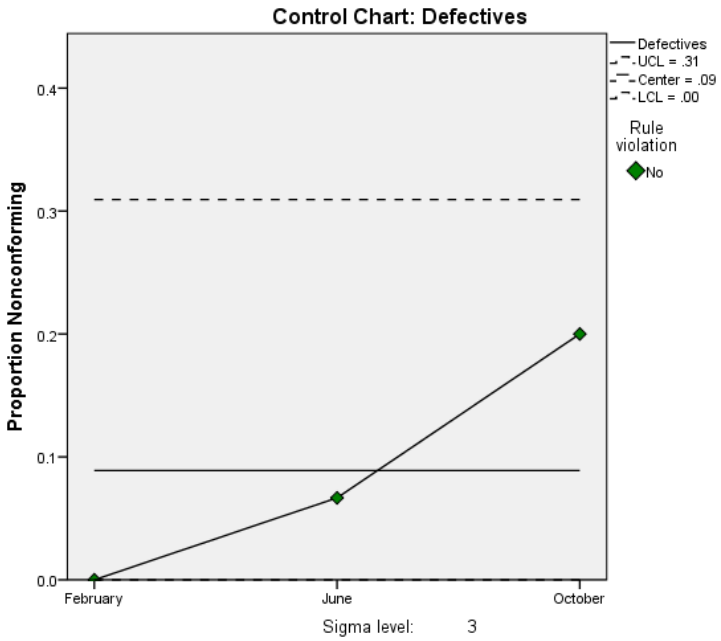
Interpretation of Result:
From table 9, the value of CP=0.299indicates that 29.9% of the paints produced within the months under investigation are within customers specified limitStandard. The value of CPK=0.266shows that Picone company is 26.6% centered at meeting customers need.

Research Question Three
What is the proportion of defectives in the manufactured paints using proportion defective chart?

Table 10:Number of Defective in 200 sampled products from paint manufacturing company one

S/N	February	No of Defectives	June	No of Defectives	October	No of Defectives
1		12		15		10
2		18		15		11
3		28		14		22
4		12		28		4
5		15		14		17
6		10		16		15
7		11		18		17
8		18		16		14
9		25		19		11
10		15		12		6
11		28		30		19
12		22		14		10
13		14		17		15
14		16		10		26
15		18		19		17

Table: 1.1.0: Proportion Defective chart for paint manufacturing company oneusing SPSS 20.1

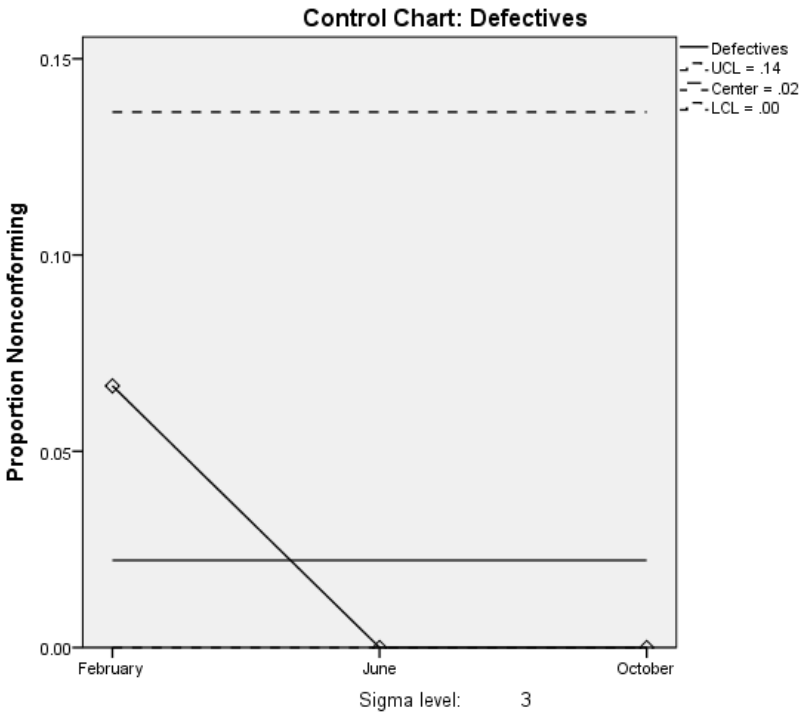


Comment Based On The Result: The Proportional defective chart above shows that there is no much defective in the manufactured goods within the period under investigation. Hence, the production process/service is under control.

Table 11: Number of Defective in 200 sampled products

S/N	PAINT PRODUCTION COMPANY TWO					
	February	No of Defectives	June	No of Defectives	October	No of Defectives
1		16		21		14
2		20		14		16
3		11		2		13
4		9		11		15
5		28		6		16
6		16		7		18
7		14		0		18
8		16		3		15
9		17		12		11
10		8		15		35
11		20		26		14
12		14		13		16
13		16		14		18
14		22		28		19
15		15		19		15

Proportion Defective chart For paint manufacturing company twoSPSS 20.1

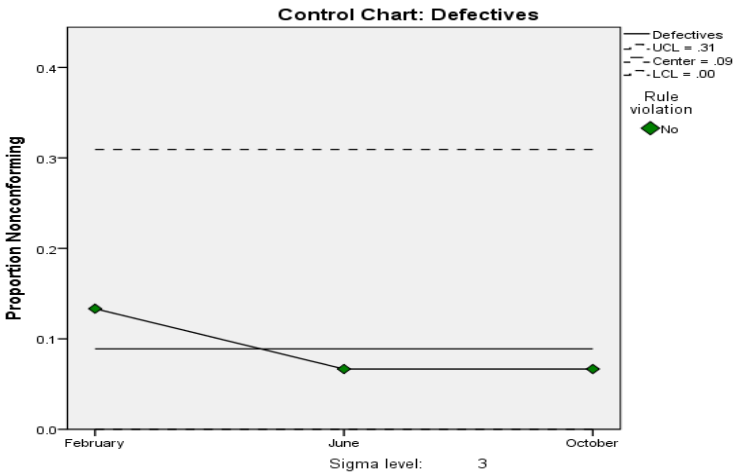


Comment Based On The Result: The Proportional defective chart above shows that there is no much defectives in the manufactured goods within the period under investigation. Hence, shows the production process/service is under control.

Table 1.3: Number of Defective in 200 sampled products from paint manufacturing company three

S/N	**PAINT PRODUCTION COMPANY THREE**					
	February	No of Defectives	June	No of Defectives	October	No of Defectives
1		15		11		15
2		12		9		12
3		12		11		15
4		14		12		16
5		15		6		17
6		17		8		19
7		16		12		12
8		17		11		7
9		18		9		16
10		6		10		18
11		11		12		12
12		15		16		12
13		18		17		10
14		19		15		13
15		14		12		4

Table: 1.3.0: Proportion Defective ChartFor paint manufacturing company three



Comment Based On The Result: The Proportional defective chart above shows that there is no much defectives in the manufactured goods within the period under investigation. Hence, it shows that the production process/service is under control.

IV. Conclusion

In conclusion, although the products are under control but they are not within customer's specified limit/Standard because the industries do not apply statistical quality control. The percentages within customer's specified limit or standard for the three companies are very poor and this could be due to the fact that customers don't fancy their products. There is need for a pragmatic approach or call for improvement of quality/standard of product so as to increase sales.

Recommendations

The companies should Endeavour to increase the quality of their product to enhance sales. Hiring of sound quality control personnel is expensive but it's of immense benefits. The three companies should redesign their system to monitor production process and avoid assignable cause of variation.

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