USE OF CONTROL CHARTS FOR ADJUST THE QUALITY OF THE WEIGHTS OF THE CEMENT BAGS PRODUCED: APPLIED STUDY OF THE FREE MARKET FOR THE SALE OF CEMENT IN ZLITEN-LIBYA

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Salma Omar Bleed
Al-asmarya University

USE OF CONTROL CHARTS FOR ADJUST THE QUALITY OF THE WEIGHTS OF THE CEMENT BAGS PRODUCED: APPLIED STUDY OF THE FREE MARKET FOR THE SALE OF CEMENT IN ZLITEN-LIBYA

Faraj Ramadan Bakeer[1],Salma Omar Bleed[2], Abd El-Salam Gendela[3]

[1]*College of Science, Statistics Department, Al-asmarya University, Zliten-Libya*
Email:Faragakir@gmail.com
[2]*College of Science, Statistics Department, Al-asmarya University, Zliten-Libya*
Email: SalmaBleed@yahoo.com
[3]*College of Science, Statistics Department, Al-asmarya University, Zliten-Libya*
Email:Stat.slam76@gmail.com

ABSTRACT

This article includes the definition of the concept of the quality and how to reach it through the use of some statistical methods for the quality control. The most important of methods is the control charts for the quantitative data of the control chart of the mean and the control chart for the range. Random samples were taken from the free market for the sale of Cement in Zliten and by using certain measures of calculating the weight of the bag of Cement produced. Reliable control charts to control the weight of the Cement bag produced are obtained, and ensured that production conforms to the required specifications in the future. It was found that the process of weighing the bag of Cement produced is in accordance with the specifications set, and that the production process is going as it should be and it is in the case of statistical control. Therefore, these charts are adopted in the future to control the quality in terms of the weight of the Cement bag. Therefore, we recommend that the responsible authorities use these charts in the future by taking samples of production and calculation the mean and the range and drawing their charts to make the appropriate decision in that the production process under control or out of control.

1.INTRODUCTION

Since twenties of the last century, the use and development of statistical monitoring charts to control the quality of production are developed by Walter Shewhart, who worked as an employee of the American company

Bell phones in 1924. He was considered as the cornerstone in the construction of statistical observation charts to control production. Through statistical information was able to benefit from access to A means of detecting the deviation and changes that may occur during the production process, where his attention was focused on detecting the major imbalances that may occur while staying under statistical control through the use of quality control charts. He published three papers in this field in the American Statistical Society. The aim of these charts was to detect random changes in the production process, where the normal distribution is the basis of the idea on which statistical observation charts were built, [3].

2. GENERAL CONCEPT OF THE CONTROL CHART

The control chart is defined as a graph method showing the upper and the lower limits of the acceptable quality level, which reflects the extent of variation in the quality of the produced units through their conformity with the targeted specifications at different intervals, and then checked and measured the quality of the property and recording the value of this property on the graph. When designing the chart of observation, it is necessary to determine the parameters of this chart as follows:

1- size (n)

2- Inspection periods (h): From a scientific point of view, the cost of sampling should be known to determine whether the optimal strategy is to take large samples during spaced periods or to take small samples at close intervals.

3- Control limits (k): Control limits may be 0.5, 1, 2, 3, ...etc, it has been customary in most studies and research on the use of 3-sigma limits, [6,9].

* The control chart consists of:

The horizontal axis is the number of observations or samples taken periodically and at regular intervals such as every five minutes or every hour or every two hours or every month and so on according to the decision of

* The senior management of the production unit.

The vertical axis represents the quality scale.

Three straight and parallel horizontal lines drawn vertically on the vertical axis: the middle line, represents the desired level of quality of the production processes is called the center line or the middle limit of the control (Central Control Limit) and is usually drawn in a continuous line and uninterrupted, [10]. The LCL: Lower Control Limit represents the minimum or minimum allowable limits due to chance factors. The upper control limit (UCL: Upper Control Limit) represents the upper limit of overrun or upper tolerance limits that are caused by chance factors, [2]. On the horizontal axis, the number of samples or time periods during which these samples are withdrawn so that the time at which the process is out of control can be determined as shown in Figure 1.

$$P(\mu - 3\sigma < X < \mu + 3\sigma) = 0.997$$

$$P(\mu - 2\sigma < X < \mu + 2\sigma) = 0.954$$

$$P(\mu - \sigma < X < \mu + \sigma) = 0.682$$

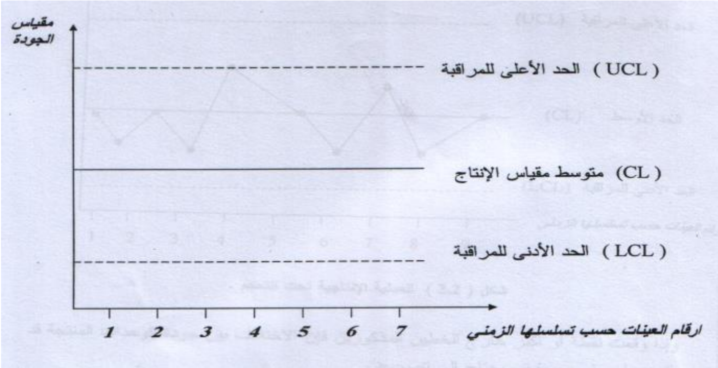


Figure 1: The general form of the control chart

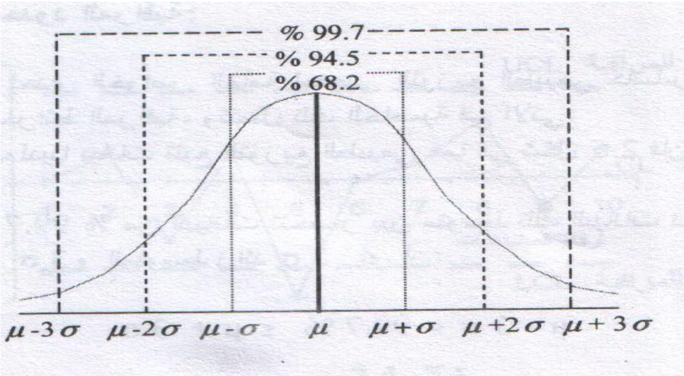


Figure 2: Probability of the normal distribution

To draw the cotrol charts, we use one of the important properties of the normal distribution curve as :If we have data follows to the normal distribution as shown in Figure 2, then:

Where is μ the average and σ is the standard deviation of the population from which the data were withdrawn, [4].

In the working life, the decision to choose that ratio depends on the amount of risk that the top management in the producing entity allows, such as 0.02 or 0.03 or so. If the ratio is 0.03, the probability that a point outside the control limits is mistaken is 0.03, i.e., the probability that a point above the upper or lower limit of the control is 0.015, [1].

3. TYPES OF CONTROL CHARTS

Control charts can be classified into two types of charts: control charts for quantitative variables and control charts for attributes or properties, and what is important to the researcher is control charts of quantitative variables without other charts. The most useful charts for quantitative variables are the arithmetic mean charts, which show the extent to which the process is occupied, and the R range charts. Those charts together are particularly effective when the focus is on determining what to measure and how to take samples, [5,8].

3.1 Control charts for quantitative variables

This type of chart is used when production quality is a feature that can be measured in practice and digitally expressed, that is, it measures the properties that can be measured in units such as length, width, weight, temperature, time, the speed … etc. Thus, each property crosses a variable that has a certain value, [7]. The samples are usually taken randomly from production, with small sample sizes. In order to reduce the differences between sample items, samples are selected within a similar time or in the same production process, and to show differences, sampling should be continued at successive intervals, as recommended sampling sizes should be equal in number.

There are several types of control charts for the variables, but the most important are the control charts for the arithmetic mean ($\bar{X}$-Chart) and the charts of the control of the range (R-Chart), [6].

3.2 The arithmetic mean chart ($\bar{X}$ - Chart)

The control charts of the arithmetic mean ($\bar{X}$ -Chart) is used to control the production process in terms of the average quality and the preparation of observation charts for the mediation of the calculation. It is known that if X is a random variable follows the normal distribution with mean μ and standard deviation σ, then the arithmetic mean is also a random variable follows the normal distribution with mean

$$\sigma_{\bar{X}} = \frac{\sigma}{\sqrt{n}}$$

μ and standard deviation.

If μ and σ are known, then

$$LCL = \mu - Z_{\frac{\alpha}{2}} \sigma_{\bar{X}} = \mu - Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

$$UCL = \mu + Z_{\frac{\alpha}{2}} \sigma_{\bar{X}} = \mu + Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

and the control limits for the sample mean are:

Lower limit: $LCL = \mu - Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$	**Middle Limit:** $CL = \mu$	**Upper limit:** $UCL = \mu + Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$

Where: $Z_{\frac{\alpha}{2}}$ is the z-value of at significance level α. If we put $Z_{\frac{\alpha}{2}} = 3$ then we have 3σ limits with $(1-\alpha)100\%$, see Figure 3.

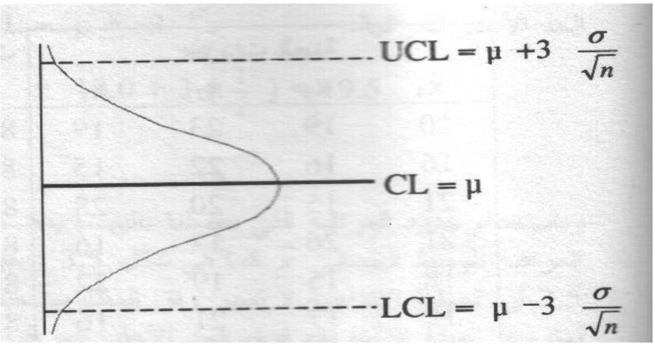


Figure 3: The Control Chart limits

If one or more of the points of the sample average occurred outside the upper and lower limits of the observation, the general mean is different from μ. This assumes that the quality characteristic follows the normal distribution, but the results are true even if that characteristic does not follow to the normal distribution (central limit theorem). Thus, the control chart limits for the arithmetic mean are as follows:

$LCL = \mu - 3\frac{\sigma}{\sqrt{n}}$	$CL = \mu$	$UCL = \mu + 3\frac{\sigma}{\sqrt{n}}$

3.3 R-Chart

The R-Chart is designed to control the production process in terms of variation or dispersion of the quality attribute of interest, despite the large diversity of control charts that can be extracted for various operations. Let $R_1, R_2, \ldots, R_k$ be the ranges for the k samples and $\bar{R} = \frac{1}{K}\sum_{i=1}^{k} R_i$, then the limits of the R-Chart are as follows:

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

Where the values of D_3, D_4 are given in table (1) for different values of n.

4. QUALITY CONTROL OF CEMENT PRODUCTION IN ZLITEN

The data were collected through a field visit over a period of one month to the free markets for the sale of Cement in Zliten. The nature of the data is the real weights of the Cement bags produced and traded in the markets with a supposed weight of (50) kg where a high quality electronic balance was measured in the period from 01/11/2017 to Target 30/11/2017, i.e., (30) random sample consisting of (5) classified and illustrated as shown in table1.

TABLE 1: THE SAMPLES OF THE STUDY

samples no.	Day / Date	Weights						
		5	4	3	2	1	Range	Mean
1	Wednesday2017/11/01	50	50.100	50	49.500	50	0.600	49.920
2	Thursday2017/11/02	50	49.750	49.575	50	48.950	1.050	49.655
3	Friday2017/11/03	50.450	51.800	50.150	52.300	52.700	2.550	51.480
4	Saturday2017/11/04	51	50.650	49	48.950	50	2.050	49.920
5	Sunday2017/11/05	48	48.100	49.300	47.675	47	2.300	48.015
6	Monday2017/11/06	50	50	50	50	49.950	0.050	49.990
7	Tuesday2017/11/07	50	50	50	50	50	0.000	50.000
8	Wednesday 2017/11/08	50	49	48.800	50	50.550	1.750	49.670
9	Thursday2017/11/09	50	50	50	49.500	48.500	1.500	49.600
10	Friday2017/11/10	50	50	50	50	50	0.000	50.000
11	Saturday2017/11/11	50	50.100	50	49.500	47.700	2.400	49.460
12	Sunday2017/11/12	49	49.200	46.600	47.100	48.350	2.600	48.050
13	Monday2017/11/13	50	50	49.900	47.950	50	2.050	49.570
14	Tuesday2017/11/14	49.800	50	48.500	49.500	50	1.500	49.560
15	Wednesday 2017/11/15	50	49.400	49.900	50	50.100	0.700	49.880
16	Thursday2017/11/16	49.785	49.200	50.450	49.950	49.900	1.250	49.857
17	Friday2017/11/17	51	50	49.850	50	50	1.150	50.170
18	Saturday2017/11/18	50	51.800	50	48.200	49	3.600	49.800
19	Sunday2017/11/19	49	50	51	50.100	50	2.000	50.020
20	Monday2017/11/20	48.100	46.600	48.800	49	50	3.400	48.500
21	Tuesday2017/11/21	50	49.375	50	50	49.800	0.625	49.835
22	Wednesday 2017/11/22	48.400	50	50	50	51	2.600	49.880
23	Thursday2017/11/23	50	50	48.500	50	50.500	2.000	49.800
24	Friday2017/11/24	49.800	46.750	47	48.400	47.900	3.050	47.970
25	Saturday2017/11/25	48.850	49.100	50.150	47.900	49.300	2.250	49.060
26	Sunday2017/11/26	51.650	49.950	50	48.900	47.750	3.900	49.650
27	Monday2017/11/27	51.250	50.050	52.150	51.750	51	2.100	51.240
28	Tuesday2017/11/28	50	49.850	49.900	50.005	49.700	0.305	49.891
29	Wednesday 2017/11/29	51.275	50.100	48.150	52	51.900	3.850	50.685
30	Thursday2017/11/30	49.975	50	48.925	50.025	49.975	1.100	49.780

Figure (4) shows that the average of the sample no.3 and sample no.27 are outside the upper limit of the control chart of the arithmetic mean, and the samples numbers (5), (12), (20) and (24) are inside the upper limit of the control chart of the arithmetic mean. As for the R chart, most of the points are located between the control limits with some points close to the minimum control, that indicating to, the dispersion of these values is small. We are creating a control chart for both $\overline{X}$ and R of the study data, and then remove samples beyond the control limits and recalculate the control chart limits based on the remaining 24 sample, see table 2:

Figure 4: the control chart for the arithmetic mean and the range R

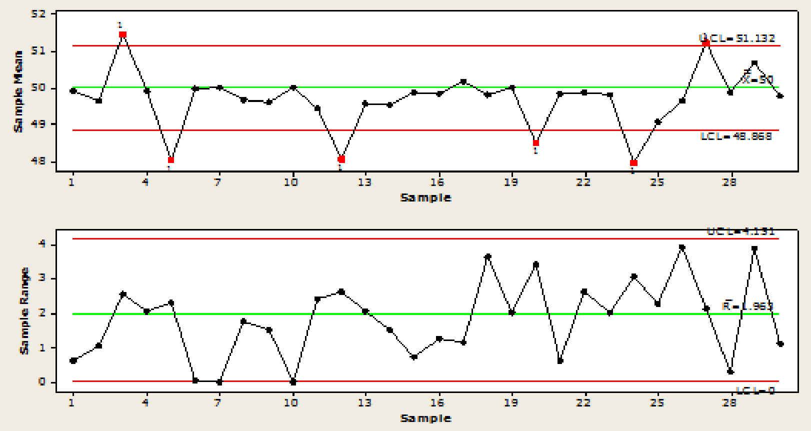


TABLE 2: THE SAMPLES OF THE STUDY

samples no.	Day / Date	Weights 5	4	3	2	1	Range	Mean
1	Wednesday*2017/11/01*	50	50.100	50	49.500	50	0.600	49.920
2	*Thursday2017/11/02*	50	49.750	49.575	50	48.950	1.050	49.655
3	Saturday2017/11/04	51	50.650	49	48.950	50	2.050	49.920
4	*Monday2017/11/06*	*50*	*50*	*50*	*50*	*49.950*	0.050	49.990
5	Tuesday2017/11/07	50	50	50	50	50	0.000	50.000
6	Wednesday 2017/11/08	50	49	48.800	50	50.550	1.750	49.670
7	Thursday2017/11/09	50	50	50	49.500	48.500	1.500	49.600
8	Friday2017/11/10	50	50	50	50	50	0.000	50.000
9	Saturday2017/11/11	50	50.100	50	49.500	47.700	2.400	49.460
10	Monday2017/11/13	50	50	49.900	47.950	50	2.050	49.570
11	Tuesday2017/11/14	49.800	50	48.500	49.500	50	1.500	49.560
12	Wednesday 2017/11/15	50	49.400	49.900	50	50.100	0.700	49.880
13	Thursday2017/11/16	49.785	49.200	50.450	49.950	49.900	1.250	49.857
14	Friday2017/11/17	51	50	49.850	50	50	1.150	50.170
15	Saturday2017/11/18	50	51.800	50	48.200	49	3.600	49.800
16	Sunday2017/11/19	49	50	51	50.100	50	2.000	50.020
17	Tuesday2017/11/21	50	49.375	50	50	49.800	0.625	49.835
18	Wednesday 2017/11/22	48.400	50	50	50	51	2.600	49.880
19	Thursday2017/11/23	50	50	48.500	50	50.500	2.000	49.800
20	Saturday2017/11/25	48.850	49.100	50.150	47.900	49.300	2.250	49.060
21	Sunday2017/11/26	51.650	49.950	50	48.900	47.750	3.900	49.650
22	Tuesday2017/11/28	50	49.850	49.900	50.005	49.700	0.305	49.891
23	Wednesday 2017/11/29	51.275	50.100	48.150	52	51.900	3.850	50.685
24	Thursday2017/11/30	49.975	50	48.925	50.025	49.975	1.100	49.780

Figure (5), show the control chart of the arithmetic mean and the R dimension after the adjustment. The points representing R and $\overline{X}$ for the remaining samples were identified, and then, we found all the sample points are located within the control limits for the arithmetic mean chart. For the R chart, we noted that there were two points (sample no.21 and 23) outside the limits of the control chart. Therefore, we will delete these two points and recalculate the control limits for the remaining 22 samples shown in the following table:

We plotted the averages of these samples on a chart and plotted the range of the samples on the R chart. The results of the drawing were as follows:

Figure 5: Chart of arithmetic mean and range R after modification

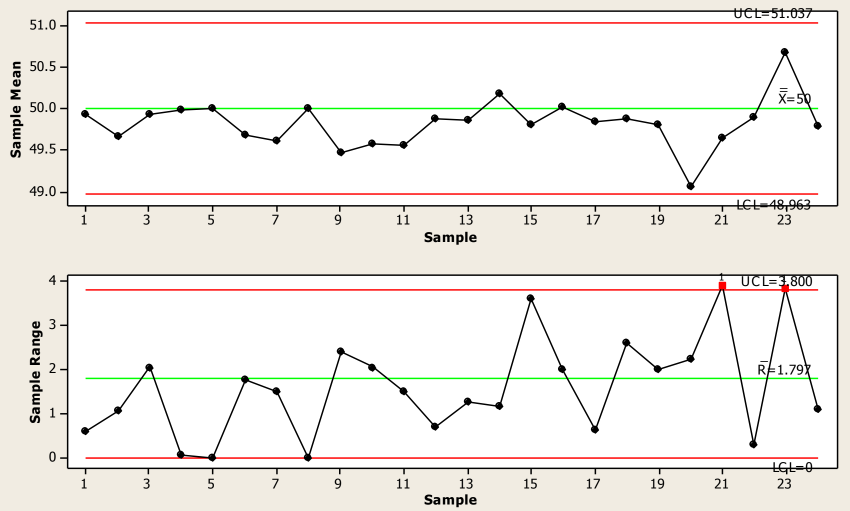


TABLE 3: THE SAMPLES OF THE STUDY

samples no.	Day / Date	Weights						
		5	4	3	2	1	Range	Mean
1	Wednesday*2017/11/01*	50	50.100	50	49.500	50	0.600	49.920
2	*Thursday2017/11/02*	50	49.750	49.575	50	48.950	1.050	49.655
3	Saturday2017/11/04	51	50.650	49	48.950	50	2.050	49.920
4	*Monday2017/11/06*	*50*	*50*	*50*	*50*	*49.950*	0.050	49.990
5	Tuesday2017/11/07	50	50	50	50	50	0.000	50.000
6	Wednesday 2017/11/08	50	49	48.800	50	50.550	1.750	49.670
7	Thursday2017/11/09	50	50	50	49.500	48.500	1.500	49.600
8	Friday2017/11/10	50	50	50	50	50	0.000	50.000
9	Saturday2017/11/11	50	50.100	50	49.500	47.700	2.400	49.460
10	Monday2017/11/13	50	50	49.900	47.950	50	2.050	49.570
11	Tuesday2017/11/14	49.800	50	48.500	49.500	50	1.500	49.560
12	Wednesday 2017/11/15	50	49.400	49.900	50	50.100	0.700	49.880
13	Thursday2017/11/16	49.785	49.200	50.450	49.950	49.900	1.250	49.857
14	Friday2017/11/17	51	50	49.850	50	50	1.150	50.170
15	Saturday2017/11/18	50	51.800	50	48.200	49	3.600	49.800
16	Sunday2017/11/19	49	50	51	50.100	50	2.000	50.020
17	Tuesday2017/11/21	50	49.375	50	50	49.800	0.625	49.835
18	Wednesday 2017/11/22	48.400	50	50	50	51	2.600	49.880
19	Thursday2017/11/23	50	50	48.500	50	50.500	2.000	49.800
20	Saturday2017/11/25	48.850	49.100	50.150	47.900	49.300	2.250	49.060
21	Tuesday2017/11/28	50	49.850	49.900	50.005	49.700	0.305	49.891
22	Thursday2017/11/30	49.975	50	48.925	50.025	49.975	1.100	49.780

Figure (6) shows that the sample mean (20) is below the minimum in the arithmetic mean chart, and for the R range chart, we observe that sample (15) is above the top of the control, therefore we will ignore these two values and recalculate the control limits for the remaining samples Which are 20 samples and are shown in the following table:

Figure 6: Chart of arithmetic mean and range R

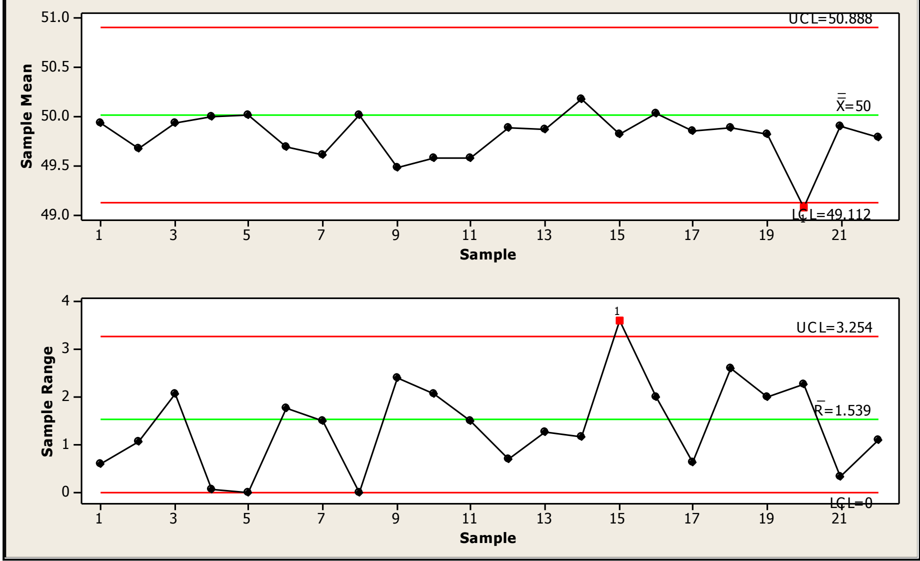
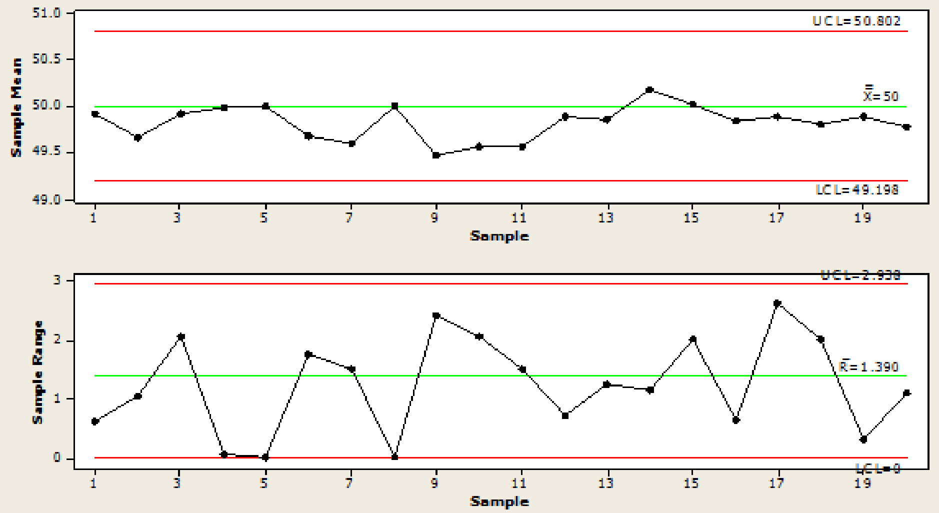


Figure (7) is the arithmetic mean and the R range in the light of the modified information, and through this figure it is clear that all the samples fall within the control limits whether for the arithmetic mean chart or the R range chart. Note that some values are close to the minimum range chart R indicating that the dispersion of these values is small and therefore the previous two charts and R will be supported.

Figure 7: Chart of arithmetic mean and range R in light Modified information



The control limits for this chart for the arithmetic mean are:		
UCL = 50.802	CL = 50	LCL = 49.198
The limits for the range are as follows:		
UCL = 2.938	CL = 1.390	LCL = 0

5.CONCLUSION AND RECOMMENDATIONS

In the study of the control charts of the mean $\overline{X}$ and the range R and after the drawing of the points representing the units measured on these charts showing the exit of some points on the limits of control and this is evidence that the process has been unusual sources of change as noted out of the case of statistical control. In the study of the reasons that led to the departure of some points from the control units, they were found because of the change of machine settings. The process of weighing the bag of Cement produced according to the specifications set It turned out that the process was going as it should have been and that it was in the case of statistical control. Therefore, these charts are to be adopted in the future to control the quality in terms of the weight of the Cement bag and the responsible parties to use these charts in the future by taking samples of the production and calculation of each of the R, and these values on the monitoring charts and make the appropriate decision in terms of production process under Control or out of control. Through the results reached, the researcher recommends the following:

1.Accuracy in the sampling process of the market.

2.The process of following these charts in terms of quality control must be carried out continuously.

3.When new samples are taken in the future and some points are found out of control, the reasons for this must be discovered and overcome to return the production process toNormal state.

4. Dependence on the ability produced by the control charts to identify problems that may result in invalid production.

5.Promote the level of documentation to keep pace with scientific development to serve future plans that help to build a clear and accurate policy to obtain reliable future predictions in the field of statistics and other sciences.

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