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Using the moving average and exponentially weighted moving average with COVID 19

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ABSTRACT

The study was concerned with clarifying the work of the quality control charts and their application in the health field, where the quality control charts for the moving average and the Exponential Weighted moving average were used to clarify the number of people infected with the Corona virus (COVID 19) for the month of April of the year 2020 and compare it with the number of people infected with the virus for the month of April of 2021, where these charts were drawn and it was found The number of injured in April 2021 is more than in April 2020, and the drawings showed the upper and lower limits of the level of injury in addition to the average number of injuries . The graphics showed the number of days out of control in the animations of moving averages and Exponential Weighted moving averages, and the study showed citizens' lack of interest in preventive methods that reduce infection with this virus and their lack of interest in urban health and not taking the vaccine for this virus in a timely manner.

Keywords: Control Statistical Quality, Random Variation, Moving Average, Exponentially Weighted Moving Average, Upper Control Limit, Lower Control Limit.

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1. Introduction

The statistical method in controlling production in general is considered one of the important methods in detecting the extent to which the product conforms to the specifications specified by the designated bodies through which the decision is made about the continuation of the production of the material or the provision of a specific service or its suspension for the purpose of limiting the departure from the specified specifications of Before the competent authority and for the multiplicity of use of quality control charts in all fields, especially industry and production processes

The first to use statistical methods in quality control in the United States of America in 1917, and these paintings were developed by the American statistician Dr. W.A. Shewart in about 1924, who was working in Bell Labs for phones, when he developed an optical device called the Quality Control Panel, where he used and developed statistical methods for the purposes of qualitative control such as frequency distributions, probabilities and normal distribution [1].

The quality control charts were used in local dental anesthesia, which is a temporary loss of sensation, including pain sensation in some part of the body, which is triggered by the application of an anesthetic substance (i.e., injection of a narcotic substance) without the occurrence of inhibition in the level of consciousness. That is given to the patient in the event of tooth infection or caries, and through the use of some control charts, such as the average plate, dispersion charts, and the accumulated total, as well as the use of the individual views panel and the moving range. From anesthesia in addition to the appropriate period for the patient to wait until the substance takes effect [2].

The methods of qualitative control extended to the fields of medicine, education, military, production, etc., Dabdoub and Younes conducted a research in which they dealt with the impact of nine variables on the lives of newborns.
Premature infants, and the fact that the nature of the data that they analyzed was consistent with the method of their research and showed the importance of quality control in the field of medicine to improve performance and raise the level of medical services [3].
Coronavirus disease 2019 (COVID-19) was first recognized in Wuhan, China in 2019. Common symptoms of COVID-19 include fever, cough, fatigue, difficulty breathing, and loss of sense of smell. Other symptoms that are less common but which may affect many patients include: pains, aches, nasal congestion, headache, conjunctivitis, sore throat, diarrhea, loss of taste and smell, rash or discoloration of hands or feet. These symptoms are usually mild and start gradually. Additionally, some people become infected without experiencing only very mild symptoms. Therefore, it was necessary to study, summarize and analyze these factors in the context of factor analysis to study a set of realistic variables related to patients registered at Al-Karamah General Hospital in Baghdad for a period from (1-4-2020) to (7-15-2020) using factor analysis with (20) variable [4].
However, we decided to use the two quality control charts in the medical field by applying the charts to the number of patients reviewing COVID 19 because of the importance of this disease at the present time and the interest of many people. And we learn about the most important methods and methods used to make the process under control. That is, the use of control charts for comparison in the measurements of Coronavirus disease 2019 (COVID-19) for the month of April 2020 and April 2021 and comparing them with the general average panel for them. We discuss the two control charts (moving average and Exponential Weighted moving average) and their application to people with Corona disease.

2. The Basic assumption of control statistical quality

Control is defined as a measure of the activities provided in a specific field (industrial or service establishment) and comparing them with the standard specifications and standards and taking the necessary corrective measures in order to obtain a quality in which the lowest level of difference from the acceptable limits.
As for quality, it is the characteristic or feature of the material produced or the service provided, which determines the degree of satisfaction of the consumer or the recipient, and it does not mean the best in its absolute meaning, but rather the degree of conformity of the product to the specifications and standard standards [5].
Statistical quality control is one of the applications of statistics in practical life, and it is the organizational processes of the activities that measure the actual performance of quality and its conformity with the standard specifications and then take the necessary corrective measures for these activities wherever they are, i.e. it is a preventive or warning control process alerting to the defect before it occurs [5].
The statistical applications have proven that any activity, whether production or service, cannot be in its optimum condition (100%) of quality, as a set of internal or external variables overlap to affect the standard specifications of the product and thus it is not possible to obtain a similar product in all respects, regardless of the degree of Accuracy in that activity
Among the types of changes are random deviations that cannot be traced back to a single cause, but rather to a large group of reasons. These differences are due to chance factor and are usually not significant and do not affect the quality of the product as long as they fall within the permissible limits. These causes cannot be completely controlled or eliminated. And non-random deviations (inevitable), which is the presence of an actual defect in one of the factors of production, and in this case the process is out of control, and it is possible to control these causes by identifying them and working to remove them where their effect is significant on the production process [5].
The idea of using the quality control charts lies in the theory of sampling and statistical inference in addition to the normal distribution
The quality control charts are considered one of the scientific methods commonly used to control the quality of the product in order to obtain a better-quality product according to the required specifications. Interest in this topic has been lost and its use developed as a result of the development of the statistical theory.
The preparation of these charts is based on the use of one of the common statistical measures such as the arithmetic mean, range, or standard deviation, and the main goal of using these charts is to detect actual abnormal changes in the parameters of the production process, which are the rate and standard deviation, and

to reveal these causes and work to remove them, if any. That is, the purpose of using the charts is to control the level of product quality or the changes and deviations in the quality [5].
As for the idea of using quality control charts, it lies in the theory of sampling and statistical inference in addition to the normal distribution.
In the event that the observations are distributed naturally at a known rate and constant and known variance, then the null hypothesis that the production process is under statistical control

$$H_0 : \mu = \text{Target}$$
$$H_1 : \mu \neq \text{Target}$$

μ: the statistical indicator of the qualitative property to be controlled.
If the null hypothesis is accepted, it means that the deviations that occur in the production process are random deviations and are determined by the acceptable normal pattern (i.e., it follows the normal distribution), this means that a high percentage of the produced materials are in conformity with the standard specifications i.e. under control.
But if it refuses, then this means that the changes are of the random type, which means that there are actual real reasons that made the process out of control or the possibility of a defect in the production process.
The theoretical basis for the work of the quality control charts is based on the normal distribution, as the charts generally consist of three lines:

1. The center line or target line: It is the standard that determines the level of required quality and symbolized by T.
2. The upper limit of the board: It is the maximum permissible limit for differences from the required level by increase, and it is symbolized by UCL.
3. Minimum plate: It is the minimum permissible difference for the level required by the increase, and it is symbolized by LCL.

The upper limit and the lower limit represent the limits of statistical allowance, so if most of the points fall in the grace period between the boundaries of control and are distributed naturally around the target line, the process is under statistical control.

From the moving averages charts [6]
Moving average (M0ving average) is very effective in detecting small changes in average productivity
Assume that a number of samples of size (n) were selected

$$M_i = \frac{\bar{X}_i + \bar{X}_{i-1} + \ldots + \bar{X}_{i-\infty+1}}{n_t}$$

The variance in the moving average panel is

$$\begin{aligned} \text{var}(\mathrm{M_i}) &= \text{var}\left(\frac{1}{\mathrm{w}} \sum_{\mathrm{i=t-w+1}}^{1} \overline{\mathrm{X}}_\mathrm{i}\right) \\ &= \frac{1}{\mathrm{w}^2} \text{var}\left(\sum_{\mathrm{i=t-w+1}}^{1} \overline{\mathrm{X}}_\mathrm{i}\right) \\ &= \frac{1}{\mathrm{w}^2} \sum_{\mathrm{i=t-w+1}}^{1} \text{var}(\overline{\mathrm{X}}_\mathrm{i}) \\ &= \frac{1}{\mathrm{w}^2}\left(\mathrm{w}\frac{\sigma^2}{\mathrm{n}}\right) \\ &= \frac{\sigma^2}{\mathrm{wn}} \end{aligned}$$

So the control limits for the moving average panel are:

$$UCL = \bar{\bar{X}} + \frac{3\sigma_{\bar{X}}}{\sqrt{w}}$$
$$\mathrm{CCL} = \bar{\bar{X}}$$
$$LCL = \bar{\bar{X}} - \frac{3\sigma_{\bar{X}}}{\sqrt{w}}$$

Where, $\bar{X}$ represents the midline of this plate [8].

3. Exponentially weighted moving average charts (EWMA)

This painting was suggested by (Robert, 1959)[10], and its formula is as follows:

$$Z_i = (1-\lambda)Z_{i-1} + \lambda X_i \qquad i > 1$$

As the initial value Z_0 Be equal to (μ) That is, the goal of the operation is $Z_0 = \boldsymbol{\mu}_0$
And λ that the primer parameter is called and its value is within the period $\mathbf{[0,1]}$.[9]
When indicating the role of a panel $(EWMA)$ for the mean $(\overline{X})$, the averages of the subgroups (Z_i) are taken to be a formula as follows:

$$Z_i = (1-\lambda)Z_{i-1} + \lambda \overline{X}_i$$

And the recurring compensation of (Z_i) When $i = 1, 2, \ldots, n$ it comes out:

$$Z_i = \lambda \sum_{j=0}^{i-1} (1-\lambda)^j \, \overline{X}_{i-j} + (1-\lambda)^i Z_0$$

Thus the variance formula (Z_i) will be

$$\text{var}(Z_i) = \sigma^2 Z_i = \frac{\sigma^2}{n} \left(\frac{\lambda}{2-\lambda}\right) \left[1 - (1-\lambda)^{2i}\right]$$

hus, the Exponentially Weighted Moving Average panel is constructed with Zi mode against the sample number i, and the center line and the control limits of the EWMA board are:

$$UCL = \mu_0 + L\sigma \sqrt{\frac{\lambda}{2-\lambda}\left[1 - (1-\lambda)^{2i}\right]} \qquad \ldots (1)$$

CCL = μ_0

$$LCL = \mu_0 - L\sigma \sqrt{\frac{\lambda}{2-\lambda}\left[1 - (1-\lambda)^{2i}\right]} \qquad \ldots (2)$$

Where L is the width of the boundary of the control
We notice that the period [1- (1-λ) ^ 2i] approaches one as i becomes larger. This means when using the EWMA several times, the control limits are close to the fixed values.[8]

$$UCL = \mu_0 + L\sigma \sqrt{\frac{\lambda}{2-\lambda}} \qquad \ldots (\mathbf{3})$$

$$LCL = \mu_0 - L\sigma \sqrt{\frac{\lambda}{2-\lambda}} \qquad \ldots (4)$$

Therefore, it is recommended to use the precise control limits in Equations 1 and 2 for small values of (i) and the control limits in Equations 3 and 4 when $i \geq 5$.

4. Application with real data

Corona virus disease 2019 is one of the modern diseases that affected the whole world without exception, so it was necessary to know the reasons for the rapid spread of this disease, so we decided to use the two quality control charts in the medical field by applying the quality control charts to a number of patients with COVID 19 when This disease is of importance and concern at the present time for many people. And we learn about the most important methods and methods used to make the process under control. Through the use of quality control charts for a group of patients registered at Al-Karamah General Hospital in Baghdad, by taking a sample of the number of admissions to the hospital in April of 2020, the number of injured during this month was 4050 injured, And compared it with another sample from the same hospital, but for April of 2021, the number of injured was 8532 injured (within the monthly statistics issued by the Hospital Statistics Division)[7]. Then applications and discussion of the quality control charts for Moving Averages and Exponentially Weighted Moving Average were conducted on the injured.

5. Result and discussion

By using the graphs of the moving average charts for the month of April 2020,and for the month of April 2021, representing those infected with Covid 19 in Karkh General Hospital, and it was as follows in Figures 1 and 2:

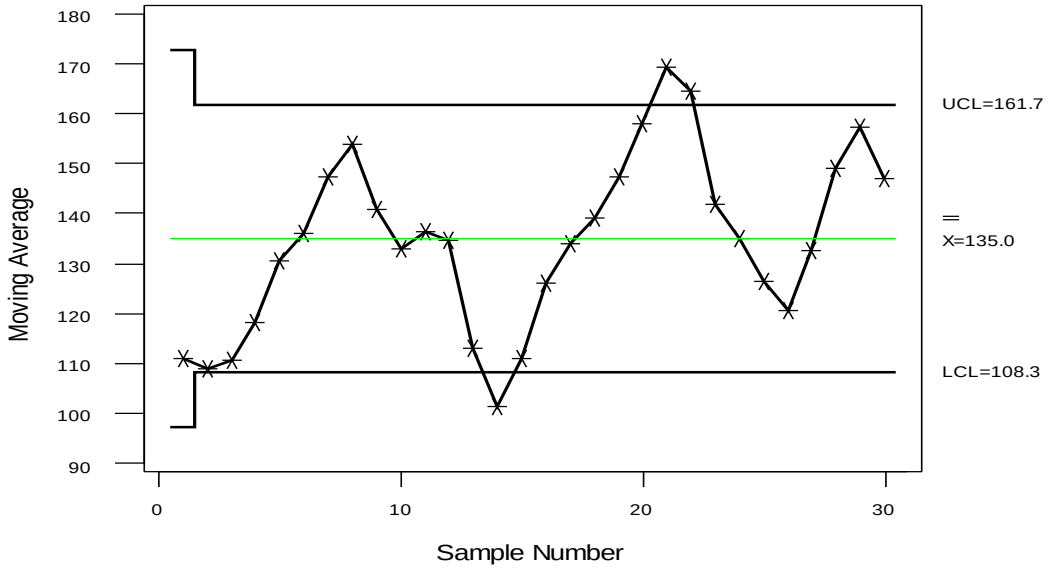

Figure 1. The Moving Average for April 2020

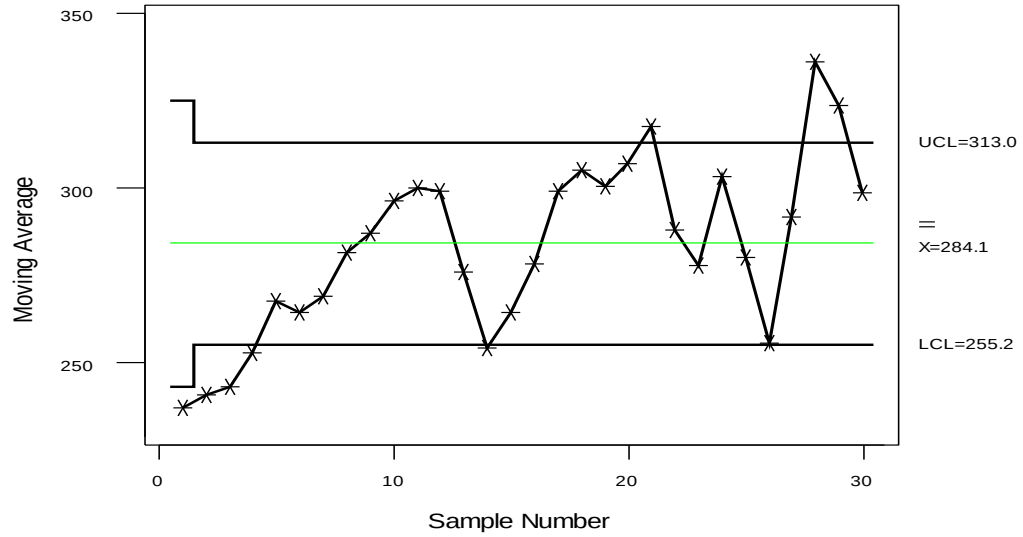

Figure 2. The Moving Average for April 2021

The results of the above graphs are summarized in Table 1.

Table 1. The Moving Average for April in 2020 and 2021

MA	UCL	$\bar{\bar{X}}$	LCL	under control	out of control
April 2020	161.7	135	108.3	27	3
April 2021	313	284.1	255.2	22	8

Through the above table of moving averages for the month of April for the years 2020 and 2021, we note that the average number of infected is 135and the number of days under control for the month of April for the year 2020 is 27 days and out of control is 3 days, while in the month of April 2021 the average number of infected is 284.1and the number of days under control is 22 days and out of control is 8 days, which indicates a lack of commitment to the health of citizens, lack of resentment for previous injuries, boredom of healthy urban , and non-compliance with it, which led to an increase in injuries in 2021.

After the data were time-weighted using the Manitab program and re-drawing the Exponentially Weighted Moving Average charts (EWMA) for the research data, we got Figures 3 and 4:

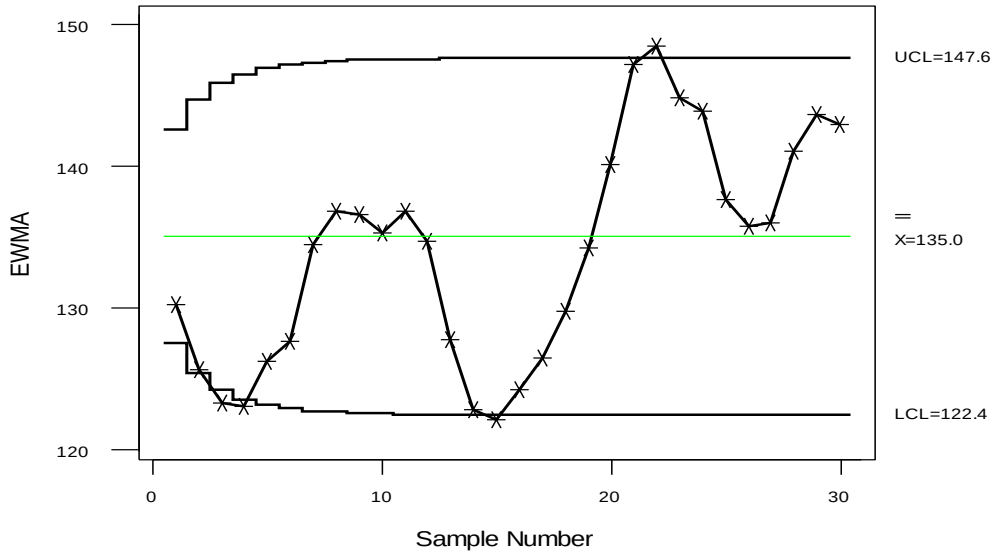

Figure 3. The Exponentially Weighted Moving Average (EWMA) for April 2020

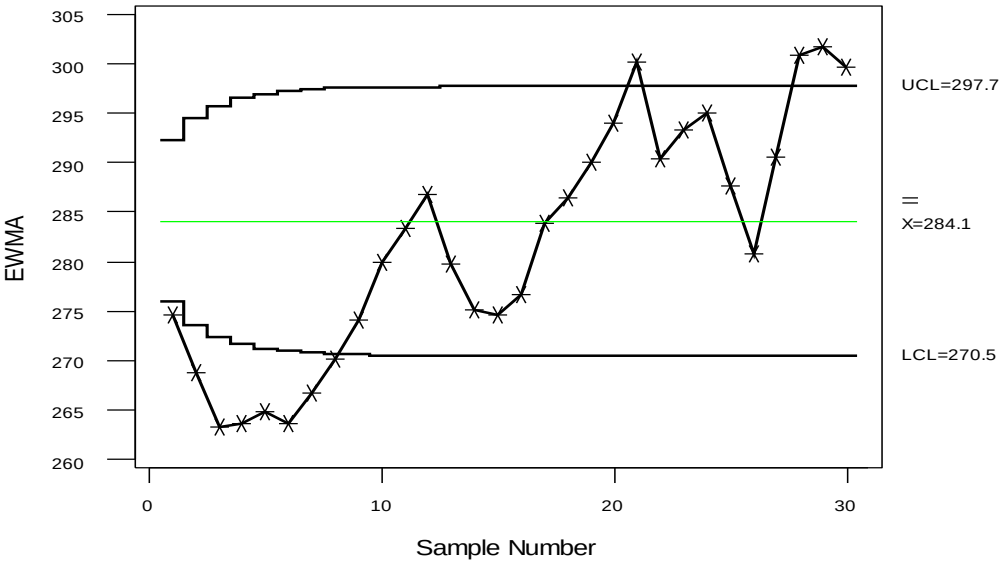

Figure 4. The Exponentially Weighted Moving Average (EWMA) for April 2021

After plotting the data with the Exponential Weighted Moving Averages charts. The results of the above graphs can be put in Table 2.

Table 2. The Exponentially Weighted Moving Average for April in 2020 and 2021

EWMA	UCL	$\bar{\bar{X}}$	LCL	under control	out of control
April 2020	147.6	135	122.4	26	4
April 2021	297.7	284.1	270.5	18	12

Through the above table of the Exponential Weighted Moving Averages for the month of April for the years 2020 and 2021, we note that the average number of infected is 135, and the number of days under control for the month of April of the year 2020 is 26 days and out of control is 4 days, while in the month of April 2021the average number of infected is 284.1and it turns out that the number of days under control is 18 days and outside

The control is 12 days, which confirms the lack of commitment to the health of citizens, the lack of interest in the number of previous infections, the boredom of the healthy urban environment, the lack of interest in the vaccine for the Corona Virus, which was found in 2021, and the lack of commitment to it, which led to an increase in infections in 2021

6. Conclusions

After drawing the qualitative control panel for the Moving Average and the Exponential Weighted Moving Average chart for the month of April 2020 and for the month of April 2021, which are shapes that represent the number of auditors for the Corona Virus, we notice that there are several points out of control for the years 2020 and 2021, but in 2021 the number of infections became double what it was in 2020, which indicates an increase in the number of patients infected with the virus, and this is due to people not complying with health instructions by wearing a mask or staying away from infected people by mixing with work, markets or closed places, which causes They have a rapid infection, as well as a failure to adhere to the urbanization imposed by the crisis cell for the health safety of the citizen. This also means that some citizens are not resentful of the injuries that occurred in 2020 and continued to violate health instructions in 2021.

References

[1] O. F. Al-Rawi, “The Use of the Discriminant Function in Specific Control with Application to the Birth of Premature Babies”, Master Thesis, College of Computer Science and Mathematics, University of Mosul, 2005.

[2] A. –R. K. Rahi, N. N. Mahdi, "A comparative study between some quality control charts in evaluating the effectiveness of local dental anesthetic, Journal of Al-Rafidain University College for Science, vol. 37, 2016.

[3] M. A. A. Dabdoub and O. F. Al-Rawi, "The use of qualitative control and discriminatory function in applied studies". Journal of Education and Science, vol. 19, no.1, 2007.

[4] I. M. Alwan, N. H. Irhaif, A. N. Abdullah, Analysis and testing of the most important factors affecting (COVID-19), Periodicals of Engineering and Natural Sciences, Vol. 9, No. 1 , pp.3-10, 2021

[5] B. G. Al-Ani, "The effect of blockade on the weights and congenital deformities of newborns using specific control", MSc Thesis, University of Mosul, 2001.

[6] J.S. Hunter, "The Exponentially Weighted Moving Average", Journal of Quality Technology, vol. 18, no.4, pp. 203-210, 1986.

[7] http://www.al-anbarhealthdirectorate-media.com. Accessed on 01.10.2020

[8] A. A.-Z. Hassan, "Quality control" (curriculum), University of Basra, College of Administration and Economics, Department of Statistics, 2018.

[9] H. F. Hussein, "Using Exponential Weighted moving average EWMA chart in mixed model ARMA", Post – Graduate Institute for Accounting & Financial Studies, University of Baghdad, 2019.

[10] M. G. Khudair,"Parametric and Nonparametric Exponential Weighted Moving Average (EWMA) Control Chart Empirical Comparative Study with Application", Al-Mustansiriya University, College of Administration and Economics, Department of Statistics, 2016.