Using Nonparametric Methods to Estimate Monitoring Maps Six Sigma of Vegetable Oil Production

Sanaa Mohammed Naeem

Southern technical university, college of health& medical Techniques in Basrah, Basrah, Iraq.
Emails: Sunamohammed70@gmail.com

Abstract

Statistics are considered the backbone of the strategies of the quality control system, because of their important role in the use of tools, theories and analysis in these strategies. in the six sigma strategies (DMAIC) and (DMADV), each step is not without statistical methods. The study relied on the application of the statistical nonparametric methods and quantitative tools used in the Six Sigma strategy to apply the quality control performance of the research sample to improve the required quality by knowing the production derivatives and the reasons for the slowdown in the production process (Al-Moatasem Factory for Vegetable Oils), the fat line with its three sections.

Keywords: Quality control; Control chart; six sigma strategies (DMAIC) and (DMADV).

1. Introduction

The element of planning and inventory management in production and operations management has become of great interest to all industrial and service establishments, as their continuity and growth has become dependent on the extent of their adaptation to their surroundings, which requires work on the continuation of production processes to achieve consumer requirements at the specified times and at the lowest possible cost, especially at the present time that imposes The policy of opening the market to imported goods without protecting the products of (local) production companies, which led to the consumer's reluctance to buy local goods because of their high prices compared to the prices of imported goods. Therefore, a study must be conducted in order to contribute to reducing the cost of local goods through the use of modern scientific methods in planning The inventory of production processes, which constitutes (15%-25%) of the cost of the final product, and accordingly, scientific studies in the field of production management focused on searching for modern technologies that contribute to reducing the cost of inventory [1,2]. Systems that work on Inventory planning, which contributes significantly to reducing the cost of stock materials, but with the progress of time and the change in the market situation and the desires of the consumer, the situation has moved from now The great need to produce according to consumer demand, which raises a number of criticisms in the hypotheses of operations research systems in the field of inventory planning, the most important of which is that the cost of the re-order point is within a certain level of storage, but in fact there may be a period in which there is no demand for production and therefore storage is carried out [3,4]. Materials without the need for them, as well as the planning of inventory materials is separate from each other (i.e. each material or part is managed separately as an independent request on its own, and the economic quantity for it and the re-order point for each part are calculated separately, and this leads to keeping a large amount of stored materials Which entails high costs, as well as the fact that the old systems of inventory planning impose fixed prices for the stored materials during the product periods [5,6]. On the contrary, we see large changes in prices because the market movement is a dynamic and

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

changing movement relative to supply and demand for the raw materials involved in the production process, and the concept of inventory control is related [7,8]. As an administrative function of inventory planning because they seek to achieve almost the same goal, they both aim to organize and maintain the movement of inventory and control the flow of materials to and from the warehouse n in the right quantity, and at the right time, without shortage or delay [9,10].
The concept of inventory control in traditional systems is to stand on the extent of implementation of established and actual plans, discover shortcomings, identify errors, deviations and abuses committed during completion, and then work to identify their causes and develop solutions to avoid them in the future. To measure and audit all warehousing operations at different times, to ensure that the required quantities are available according to the plans set, to check the receipt and disbursement of materials to the warehouses, and to ensure their validity. The final as applied in the modern systems of control (MRP) [11].

A. Research Objectives

There is more than one goal of the research represented by theoretical framing of the concept of hexagonal diffraction and its methodologies. The second objective is to design an applicable model that defines the role of statistical methods in six-sex scattering. The third objective is to identify quality control and analyze its reality for real data.

2. Quality control

H-g, Wellez explained in 1925 that statistical thinking will have the importance of writing and reading for the competent citizen in the future. The age of industry depends on understanding statistics, which are like a powerful microscope, through which we can see things that we could not see before, as industries began to direct a huge amount of money to train employees in statistical methods in order to improve quality [12,13].
As the dictionary of quality control terms, issued by the European Organization for Quality Control, defines, Statistical Quality Control is that part in which statistical methods are used for quality control. These methods include frequency distributions, measures of central tendency, dispersion, control panels, sampling plans for acceptance, regression analysis, significance tests...etc.
Control Charts and Acceptance Sampling Plans are among the most important of these methods.
The science of statistical quality control began in 1926 when Walter A. Shewhar, who was working in Bell Telephone Laboratories in the United States, prepared research on statistical control boards, which to this day are considered the main tool for controlling product quality during its manufacturing stages and provide quality controllers with continuous observations. About the progress of the production process and their ability to detect the changes occurring between the producing units and whether these changes are coincidental or not coincidental [14,15].
As for the development of Inspection Sampling Techniques and the design of Acceptance Sampling Plans, credit is due mainly to V.F.Dodge and H.G.Romig, who in 1944 published the famous tables known by their names [16]V.
The statistical methods used in quality control usually depend on the pattern of the characteristics of the production system. There is a pattern of grouping control and a pattern of control known as the flow of operations, which is concerned with monitoring the manufacturing stages of production that is characterized by a great degree of accuracy and complexity, such as building machines and aircraft. Another pattern of control is the pattern of sampling, which is used in the examination and control of part of the production outputs and in certain proportions chosen at random. This pattern is used to check and control the characteristics of the outputs in terms of measurements, size, shape, etc.
As for the continuous control pattern, it is used to examine the produced units, one after the other, which require extreme accuracy in their measurements and manufacturing conditions, such as making molds.
Accordingly, quality control can be defined as all the activities and efforts exerted by all employees in the facility, which combine to achieve the desired standard levels of quality.

A. The development of quality control systems

The emergence of quality systems in our modern era in the nineteenth century. Here is a summary of the development of these systems:

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

1. **Quality control by worker:** This system is considered the first step in the development of quality control, as the worker was responsible for producing the entire product and controlling its quality. This type of control was prevalent until the beginning of the twentieth century.
2. **Quality control by the foreman**: This stage began with the beginning of the twentieth century, when many factories arose, and a kind of specialization began to emerge in performance, meaning that each group of workers performs similar work that combines with each other for a specific production, in the presence of a boss for these workers who monitors the quality of their work.
3. **Quality Control by Inspection:** During the First World War, an industrial renaissance began, as production became more complex and increased to a large extent, which led to the need to appoint full-time workers for the process of examining products and controlling their quality.
4. **Production quality control**: It arose with the beginning of World War II and the great industrial renaissance in the world to control the huge quantities of products by adding some control methods such as sampling.
5. **Integrated control of production quality**: It appeared at the beginning of the sixties, and it is an effective system that included four basic elements to control its quality, which are (design, raw materials, product, and production process).
6. **Total Quality Management:** At the beginning of the eighties, the concept of integrated control of the quality of production developed into total quality management, which is an integrated administrative and technical system that covers all stages of industrial activity. From here emerged the international standard specifications ISO 9000, which appeared in 1987 and amended in 1994 and 2000 to ensure and confirm the quality of the system that produces products, transcending the old concept of product quality only.
7. **hexagonal diffraction:** It is a comprehensive, perceptive and flexible system of leadership defined as a systematic extension of total quality management that supports and develops business success and is exceptionally close to understanding customer requirements. Its beginnings were at the end of the eighties and it was launched by Motorola. It works through two methods:
    A. DAMIC stands for Proof of Improvement by Finding Optimal Solutions.
    B. DMADV which is the design process.

    The following figure (1) shows the quality system development plan

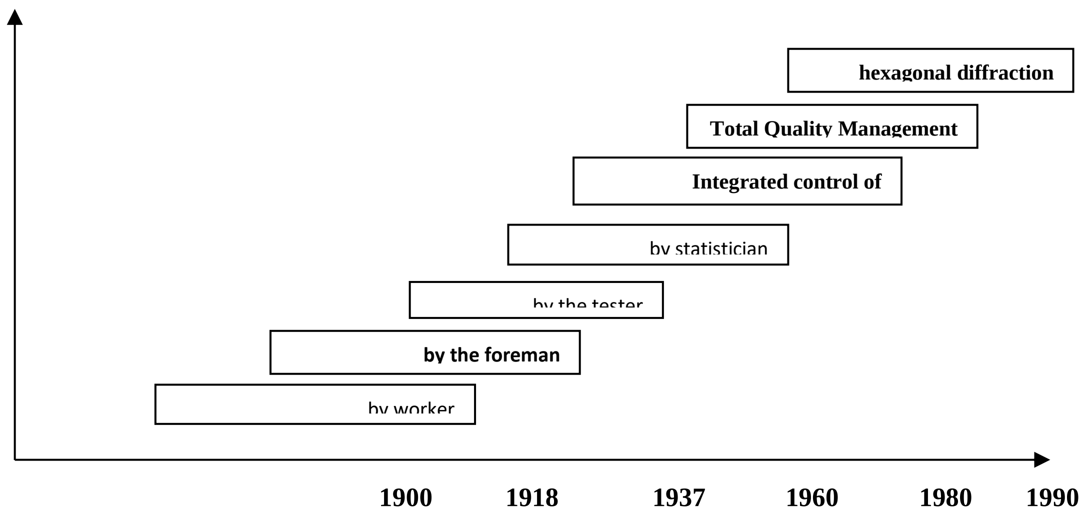


Figure 1: The quality system development plan.

3. Statistical methods in quality control

B. The principles of probability theory and its applications

The applications of probability in quality control are one of the basic topics presented by statistical theory, and to clarify the concept of probability in quality control, it means the recurrence and homogeneity in the occurrence of a case of non-conformity with the specifications, as well as the relative stability of the case in light of the approved conditions and variables. For example, if one of

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

them said that his production of one of the commodities in which the percentage of units that did not conform to the specifications was 3%, and therefore determining the possibility of the occurrence of the situation is one of the distinguishing characteristics of the repeated operations, according to which we can predict the results of the operations before they occur, in addition to that we benefit from their applications in The method of accepting samples is by making a decision to accept or reject the batch as a program of operating characteristics curves, which is based on a number of variables, including:

1) **Acceptable quality level**: It means the smallest percentage of defects that lead to acceptance of the batch and achieve the consumer's desire.
2) **The percentage of defects in the batch:** It is the largest percentage of defects that lead to the rejection of the batch and does not fulfill the consumer's desire.
3) **Product Risk (α):** It means the probability that the batch is at an acceptable quality level but is rejected.
4) **Consumer risk** (β): It means the probability of accepting the batch with a high percentage of defects. There are statistical tables used to examine the sample and determine the probability of acceptance or rejection, including Romj and Dodge tables.

As for the measure of probability, it represents the number of possible cases for the occurrence of the incident whose probability is to be known over the total number of cases.

Control chart: It is an important tool in the analysis of performance and control and is used in the methodology of optimization in the six diffraction in the case of analysis, the control maps are what judge whether the process is predictable. In terms of control, it is to prove the efficiency of the process that it is under control. The beginning of its use goes back to Walter Shewhart in 1924, and the control panel is defined as a graphic map used as a means to take the appropriate decision regarding the progress of the production process at a specific production stage according to the path specified for it. This is done by drawing time random samples from the production batches after determining the characteristic of the produced unit or variable, which reflects its quality.

Therefore, conducting continuous statistical analysis of the change in the quality level of production or the main characteristics of the product enables one to distinguish between the natural variation resulting from the random sources inherent in the production process, and the causal variation that can be discovered and treated before producing more units outside the required specifications. Shewhart's tuning maps track the impact of the production process by plotting data with time, and the data is represented by a characteristic or a variable. The types of maps used for continuous variables are:

1) Average and range charts.
2) Average and standard deviation charts x-s (average and standard deviation).
3) X-Rs (individual observation and moving rang) chart.

As for the maps used for the discrete variables that represent the trait (Attributes), they are:

i. P fraction of non-conforming items.
ii. NP (number of non conforming items) chart.
iii. C(number of defects) chart.
iv. The number of errors or defects in each unit. U (number of defects per unit) chart.
v. There are other types of control maps for continuous data that are suggested and taken into consideration, namely:
    - Cumulative sum maps. USUM (Cumulative sum) chart.
    - Moving average maps. MA (moving average) chart.
    - GMA (geometric moving average) chart.
    - EWMA (exponentially weighted moving average) chart.

To organize the control maps, follow the following:

1. Determine the elements to be monitored, including errors, and know their characteristics, and from which the type of map that will be used can be determined.
2. In most cases, the sample that is taken in the case of continuous data has a number of observations from 2 to 6. However, there are maps for partial groups consisting of one observation, such as X (individual observation) and Rs (moving rang), and for discrete data, the sample size must be

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

large so that It contains 100 or 200 observations and the number of samples taken is from 20 to 30 samples.

3. Calculating the lines of control and the center line, as the control maps have two lines of control. Upper Control Limit (UCL), which is the upper limit of control. Lower Control Limit, which is the lower limit of control and symbolized by (LCL).

Center Line: which is the center line that lies between the limits of control and represents the approved standard or the arithmetic mean of the values of the phenomenon and is symbolized by (CL), and the distance between (CL) and the limits of control is three standard deviations of the approved specification. The following is the method for determining the control error and the center line for each of the center and range maps.

$$\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n} \quad , \quad \bar{\bar{X}} = \frac{\sum_{i=1}^{m} \bar{X}_i}{m} \quad \text{and} \quad \bar{R} = \frac{\sum_{i=1}^{m} R_i}{m}$$

$\bar{\bar{X}}$ The mean is the mean of the samples. $\bar{X}_i$ represents the arithmetic mean of sample i.

m represents the number of samples.

R is the sample range rate. Ri represents the sample range i.

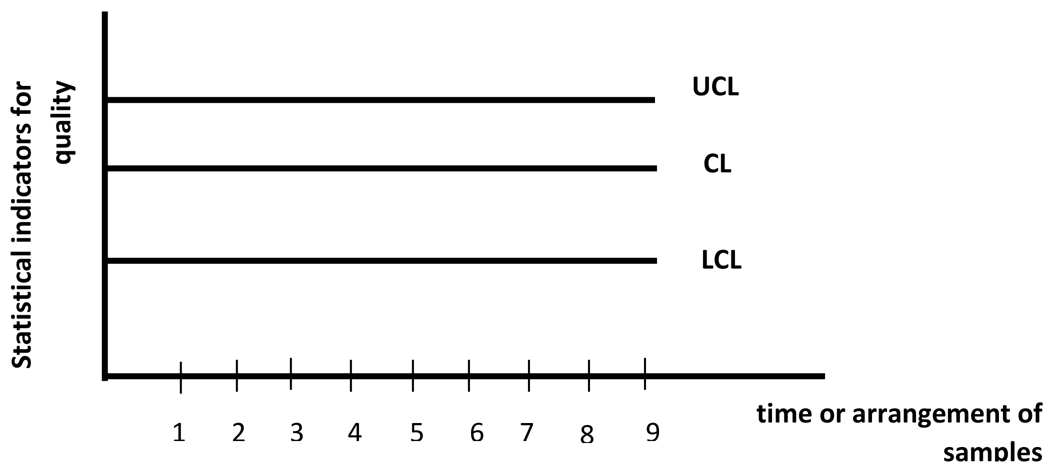
Accordingly, X will be the CL of the mean map (center line) and R is the CL of the range map (center line). As for the two control lines, they are extracted from the following relations:

$$UCL_{\bar{x}} = \bar{\bar{X}} + 3\sigma_{\bar{x}} \quad \text{and} \quad UCL_R = \bar{R} + 3\sigma_R$$
$$LCL_{\bar{x}} = \bar{\bar{X}} - 3\sigma_{\bar{x}} \quad \text{and} \quad LCL_R = \bar{R} - 3\sigma_R$$

Or the following formulas can be used:

$$UCL_{\bar{x}} = \bar{\bar{X}} + A_2\bar{R} \quad \text{and} \quad UCL_R = D_4\bar{R}$$
$$LCL_{\bar{x}} = \bar{\bar{X}} - A_2\bar{R} \quad \text{and} \quad LCL_R = D_3\bar{R}$$

Whereas A2, D3, and D4 are commonly used constants for adjustment maps.



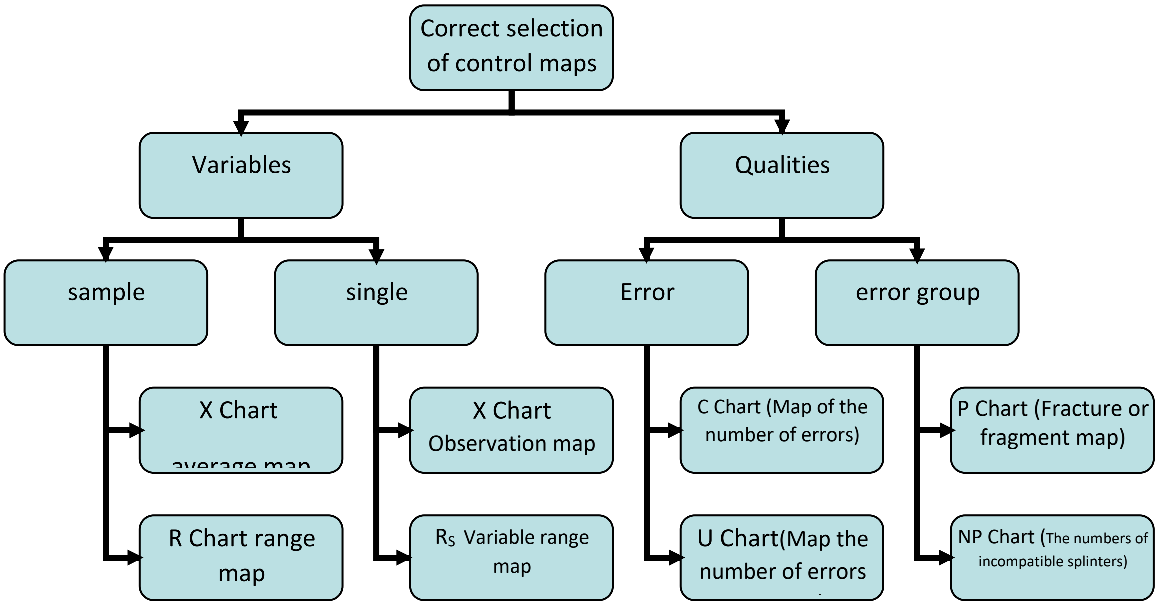
As for the special cases of variance that are discovered through drawing control maps, they are:

1) If a single point is out of bounds of control ($3\sigma \pm$).
2) If there are two of the three consecutive points located outside ($2\sigma \pm$) of the boundary.
3) If there are seven or more consecutive points located on one side of the center line (CL).
4) If there are eight or more consecutive points that take the rise or fall. In decreasing trend or in increasing trend.
5) At least 10 points from 11 consecutive matches fall on one side of the center line.

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

6) At least 8 consecutive points make a circle, i.e. one of the points lies on one side of the center line and the second on the other side of the center line.

The following diagram shows how to choose the adjustment maps according to the type of variables.



We notice through this chart, and to choose the appropriate control map for the data under study, its type must be determined. If there are variables such as weight, height, or ..... etc., then we choose variable maps. If the data under study is a group of samples, we choose the X Chart or the average map. Range (R Chart). But if the data under study is a single group, then we choose the single observation map or the variable extent map. Note that the rate maps give an idea of the extent of data concentration around the set target point, while the range maps show the extent of the dispersion of the studied data from the target set for it.

But if the data under study bears characteristics, such as the number of errors or defects, there are two basic types of control charts, if the case is controlling the number of errors in production meals, i.e. samples we use P Chart or NP Chart. But if the number of errors is represented by production units, we use the C Chart, and if it is required to adjust the number of errors in each productive unit, we use the U Chart.

In the field of the study, the quality control department at Al-Mu'tasim Factory for Vegetable Oils lacks the method of using control maps, due to the negligence of the staff involved in applying statistical methods in quality control and their reliance on laboratory tests to place the basic elements within the limits of the specification without revealing the centralization of the production process or the amount of its dispersion.

Confidence Intervals: The exact derivation of confidence intervals (CI) for monotonous estimators, and therefore most of the (IR) estimators are very difficult. The alternative is to use re-sampling methods, as we assume that the errors have been determined to be a normal distribution and the variance has been determined to be constant. The important characteristic of the errors is naturally the distribution an estimate in the loess is linear if:

$$\hat{g}_{(x_i)} = \sum_{i=1}^{n} L_i(x_i) y_i$$

$L_i(x_i)$ don't depend on y_i

The linear results of the distribution characteristics of the estimate are similar to the classical parametric matching according to the following steps:

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

1) **First: Estimation the variance:** Since $\hat{g}_{(x_i)}$ is linear in y_i , the value estimated at x_i can be written as follows:

$$\hat{y}_i = \sum_{j=1}^{n} L_j(x_i)y_j$$

Since: [L] the matrix of the smoothers represents its elements(i, j)th and represents $L_j(x_i)$, and let us assume that:

$\bar{L} = I - L$; I : It represents the unit matrix with degrees $(n * n)$.

When $K = 1,2$ that $\delta_K = tr(\bar{L}'\bar{L})^K$ and $v = \frac{\delta_1^2}{\delta_2}$

It is estimated σ^2 , which represents the residual variance estimator, as follows:

$$S^2 = \frac{\sum_{i=1}^{n} \hat{\varepsilon}_i^2}{\delta_1} \;;\; S^2 = \frac{\sum_{i=1}^{n} [(Y_i - g_{(xi)})]^2}{\delta_1}$$

As for the confidence interval for the scientist John Fox explained the following:

$\hat{y}_i = \sum_{j=1}^{n} L_j(x_i)y_j$; Where is the set of transactions $[L_{i1}, L_{i2}, \ldots\ldots\ldots, L_{in}]$ represent ith from the rows of the matrix [L] : $\hat{y}_{(n\times1)} = L_{(n\times n)}y_{(n\times1)}$

and the variance of the estimated value is directly calculated:

$$V\left(\hat{y}\right) = L\,V\left(y\right)\,L = \sigma_\varepsilon^2 LL'$$

To find the above equation requires finding the error variance $\left(\sigma_\varepsilon^2\right)$ This requires that we find the degree of freedom of the sum of the squares of the error, and between each of Fox that the simplest way to find it is as follows:

[L] the matrix of the smoothers In the loose are:

$L \equiv X(X'WX)^{-1}X'W$ and $e = (I_n - L)y$

The number of parameters in the model is found according to the following equation:

$trace(L) = \tau$; and the degree of freedom of the residuals can be represented by the following:

$$df_{res} = trace(I_n - L) \Rightarrow df_{res} = tr(I_n) - tr(L)$$

$$= n - \tau$$

Therefore, the estimated formula for variance error can be written as follows:

$S^2 = \frac{\sum e_i^2}{df_{res}}$; The degree of freedom of the residuals is:

$df_{res} = n - df_{mod}$

For the degree of freedom of the nonparametric regression model, it takes more than one formula as mentioned by Cleveland et al. and Fox, as follows:

$$df_{mod} = trace(L)$$

$$df_{mod} = trace(LL')$$

$$df_{mod} = trace(2L - LL')$$

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

And we can say that the confidence interval is the process of limiting the true value of a parameter between a lower and upper confidence limit with a certain probability of $(1-\alpha)$ Therefore, the confidence interval is at 95% as follows:

$$pr\{y_i - 2SE\sqrt{v_{ii}} < y < y_i + 2SE\sqrt{v_{ii}}\} = 1-\alpha$$

Where : $v_{ii} = \text{trace}(LL')$

The researcher strand developed the confidence interval as follows:

$\hat{g}_{(x_i)} = \sum_{i=1}^{n} L_i(x_i) y_i$; Then the standard deviation of $\hat{g}(x)$ is:

$\sigma(x) = \sigma\sqrt{\sum_{i=1}^{n} L_i^2(x)}$; What estimate $\sigma(x)$ is: $S(x) = S\sqrt{\sum_{i=1}^{n} L_i^2(x)}$

Therefore, the sampling distribution is approximate to the t distribution with degrees of freedom (v), as follows:

$t = \frac{\hat{g}(x) - g(x)}{S(x)}$ *and* $v = \frac{\delta_1^2}{\delta_2}$

Therefore, the confidence interval (NPR) based on the t-distribution takes the following form:

$$pr\left\{\hat{g}(x) - t_{\frac{\alpha}{2},v} SE^{g}(x) < g(x) < \hat{g}(x) + t_{\frac{\alpha}{2}} SE^{g}(x)\right\} = 1-\alpha$$

$t_{\frac{\alpha}{2},v}$: Represents the tabular value associated with the region $\frac{\alpha}{2}$ for a t distribution with degrees of freedom (V).

Thus, the confidence limits for the estimates of the used methods apply to the above equation in extracting them in case the sample size is less than (30).

$\hat{\mu}(x) \mp t_{\frac{\alpha}{2},v} SE^{g}(x)$

As for the confidence limits in the case of the sample size being greater than (30), they can be clarified as follows:

$\hat{\mu}(x) \mp Z_{\frac{\alpha}{2}} SE^{g}(x)$

4. Estimation Methods

A. local polynomial regression

The loess is an acronym for Locally weighted scttarplot smoothing, which some consider as synonymous with modern modeling, which is based on the classic method such as linear and nonlinear least squares regression. This is because we can know the appropriate parametric formula for the slope surface. In addition, the loess method is suitable when there are outlier values.

Perhaps the main characteristics of the loess method can be summarized as follows:

1. Match and fit the non-parametric models.
2. It supports the multi-directional use of the forecast.
3. Supports multiple dependent variables.
4. Supports both direct and deviant matching using k-d trees.
5. Confidence intervals are calculated for the predictors.

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

6. Supports the calculation of multiple data aggregates.

The implementation of the loess requires determining the degree of local polynomial smoothing (d) and the value of the bandwidth (h), which controls the level of smoothing of the appropriate function.

As the degree of polynomials in parametric regression plays a role similar to the degree of smoothing in non-parametric regression, and the scientist Stone clarified that the lower the degree of preparation for the regression model of polynomials, it is locally appropriate if the correct regression curve is smoothed.

B. Local polynomial simple regression

As mentioned above, positional polynomial regression is a flexible way to match the nonparametric polynomial regression model

$$\mu|x_1, x_2, \dots x_p = f(x_1, x_2 \dots x_p)$$

The objective of simple local polynomial regression is to estimate the regression function $\mu|x$ at the focal point value $x = x_0$, and we perform weighted least squares (WLS) regression for $y|x$ observations whose values x approach the focal point x_0 .

According to the following steps:-

1- Calculating the kernel function represented by $k(X_i - x_0)$, which achieves the highest weight for close views to the focal point x_0 and then decreases symmetrically as it gets $|X_i - x_0|$ larger.

We will use the tricube kernel function to calculate the weights and assume:

$$Z_i = \frac{(X_i - x_0)}{h}$$

Z_i represents the measured distance between the predictor value of $_i$th from the observations and the focal value x_0 .

The tricube kernel function is:

$$K_T(Z) = \begin{cases} (1 - |Z|^3)^3 & for |Z| < 1 \\ 0 & for |Z| \geq 1 \end{cases}$$

2- Using the kernel weights, we regression WLS of the dth $Y|X$ degree polynomial to fit the following equation:

$$Y_i = \beta_0 + \beta_1(X_i - x_0) + \beta_2(X_i - x_0)^2 + \dots + \beta_p(X_i - x_0)^d + \varepsilon_i$$

From the standard weighted least squares theorem, we get:

$$\hat{\beta} = (X^T W X)^{-1} X^T W Y$$

$\underline{Y} = [Y_1 \dots Y_n]^T$ which is a vector for responses.

And a matrix X of degree n×(p+1) can be represented as follows:

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

$$X = \begin{bmatrix} 1 & (X_1 - x_0) & (X_1 - x_0)^2 \ldots & (X_1 - x_0)^p \\ . & . & . & . \\ . & . & . & . \\ 1 & (X_n - x_0) & (X_n - x_0)^2 \ldots & (X_n - x_0)^p \end{bmatrix}$$

Whereas, local polynomial regression is generalized to estimate the kernel function for local matching at the focal point using W-weights as:

$$\mathrm{W} = \mathrm{diag}\left\{\mathrm{k}\left(\frac{\mathrm{X}_1 - \mathrm{x}_0}{\mathrm{h}}\right), \ldots, \mathrm{k}\left(\frac{\mathrm{X}_\mathrm{n} - \mathrm{x}_0}{\mathrm{h}}\right)\right\}$$

The positional estimator of the polynomial kernel function is a weighted regression of the data, centered around x_0 the objective and is an estimate $g(x_0)$.

We note that if we assume (d) is the degree of smoothing of the polynomial and it is identical at the point x_0, then the estimate $g(x_0, d, h)$ we get from matching the polynomial.

When d = 0, the loess tends to estimate the Nadaraya-Watson nucleus

$$Y_i = \beta_0 + \varepsilon_i$$

And then we find the least limit of the weighted sum of squares of the error as follows:

$$\sum W_i \varepsilon_i^2 = \sum_{i=1}^{n} k\left(\frac{X_i - x_0}{h}\right)(Y_i - \beta_0)^2$$

we derive with respect to β_0 $\Rightarrow \frac{d}{d\beta_0} \sum_{i=1}^{n} k\left(\frac{X_i - x_0}{h}\right)(Y_i - \beta_0)^2$

equal to zero, then: $\sum_{i=1}^{n} \mathrm{k}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right) \mathrm{Y_i} = \hat{\beta} \sum_{i=1}^{n} \mathrm{K}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right)$

$$\therefore \hat{\beta}_0 = \frac{\sum_{i=1}^{n} k\left(\frac{X_i - x_0}{h}\right) y_i}{\sum_{i=1}^{n} k\left(\frac{X_i - x_0}{h}\right)}$$

$$\therefore g(X_0, 0, h) = \hat{\beta}_0$$

And when d = 1, the loess tends to a local linear regression, and we start with a definition as Y_i follows: $\mathrm{Y_i} = \beta_0 + \beta_1(\mathrm{X_i} - \mathrm{x}_0) + \varepsilon_\mathrm{i}$

By the same steps above, we can find the minor limit as follows:

$$\sum \mathrm{W_i}\, \varepsilon_\mathrm{i}^2 = \sum \mathrm{k}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right) [\mathrm{Y_i} - \beta_0 - \beta_1(\mathrm{X_i} - \mathrm{x}_0)]^2$$

We find the partial derivative and depending on we get:

$$= 2 \sum \mathrm{k}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right) [\mathrm{Y_i} - \beta_0 - \beta_1(\mathrm{X_i} - \mathrm{x}_0)]$$

Finding the partial derivative and depending on β_1, we get:

$$\hat{\beta}_1 = \frac{\sum_{i=1}^{n} \mathrm{k}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right) \mathrm{Y_i} - \hat{\beta}_0 \sum_{i=1}^{n} \mathrm{k}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right)}{\sum_{i=1}^{n} \mathrm{k}\left(\frac{\mathrm{X_i} - \mathrm{x}_0}{\mathrm{h}}\right)(\mathrm{X_i} - \mathrm{x}_0)^2}$$

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

$$\therefore \hat{\beta}_0 = \frac{\sum_{i=1}^{n} k(.)Y_i(X_i - x_0)\sum_{i=1}^{n} k(.)(X_i - x_0) - \sum_{i=1}^{n} k(.)Y_i \sum_{i=1}^{n} k(.)(X_i - x_0)^2}{(\sum_{i-1}^{n} k(.)(X_i - x_0))^2 - \sum_{i=1}^{n} k(.)\sum_{i=1}^{n} k(.)(X_i - x_0)^2}$$

$$k\left(\frac{X_i - x_0}{h}\right) = k(.)$$

$$= g(X_0, 1, h)$$

This is the local linear estimate for d=1 .

Accordingly, when the preparatory degree is (d = 2), the loess tends to the local quadratic regression, as follows:

$$Y_i = \beta_0 + \beta_1(X_i - x_0) + \beta_2(X_i - x_0)^2 + \varepsilon_i$$

And from the standard weighted least squares theorem we get:

$$\hat{\beta} = (X^T W X)^{-1} X^T W Y$$

5. Examination plans used in the quality control department for the study sample

As for the application of the study, the Quality Control Department at Al-Moatasem Factory for Vegetable Oils in Maysan uses the single examination plan for the purpose of detecting the main elements involved in the composition of the fat, which are (fatty acids, iron, peroxide, color) whether they are within the limits of the applicable standard. If this is the case, the production continues, but if there is a difference in any of these four elements, then it is dealt with. Another sample is taken, and so on, with the limits of a sample for each working hour.

A. The stage of control

At this stage, it is emphasized that the conditions of the production process are documented and under monitoring, by statistical control methods (SPC). One of these methods is control maps. (15) samples were taken from the final production of the produced fat and the readings of the four elements (R, Fe, FFa, Pr At a rate of 5 readings for each sample.

After extracting the range and arithmetic average of these readings, two maps of the range and average were drawn for each element, as shown in the following:

Figure (2) represents the adjustment map for the rate, noting that the adjustment limits were extracted from the equations mentioned in the two chapter.

$$UCL_x = \overline{X} + A_2\overline{R} = 0.217 UCL_x = \overline{X} + A_2\overline{R} = 0.217$$

$CL_{\overline{x}} = \overline{X} = 0.159$ and $LCL_x = \overline{X} + A_2\overline{R} = 0.102$

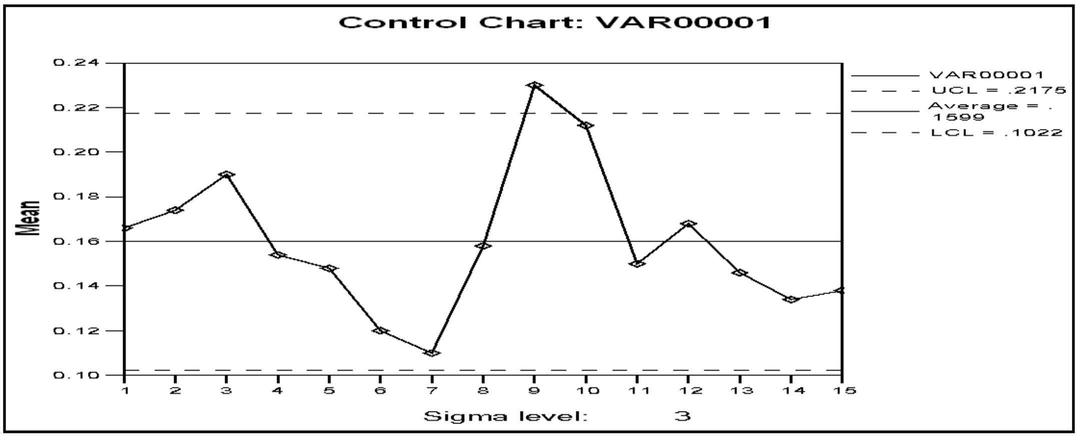


Figure 2: Rate setting map for the F.F.A. element.

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

We note that most of the samples are within the control limits, except for sample No. (9), which is outside the upper control limit of the rate map, which indicates the existence of a special discrepancy.

As for the extent map, figure (3), its boundaries were calculated as follows:

$UCL_{\overline{R}} = D_4\overline{R} = 0.2115$

$CL_{\overline{R}} = \overline{R} = 0.1$ and $LCL_{\overline{R}} = D_3\overline{R} = 0$

$$UCL_x = \overline{\overline{X}} + A_2\overline{R} = 0.217$$

$$CL_{\bar{x}} = \overline{\overline{X}} = 0.159$$

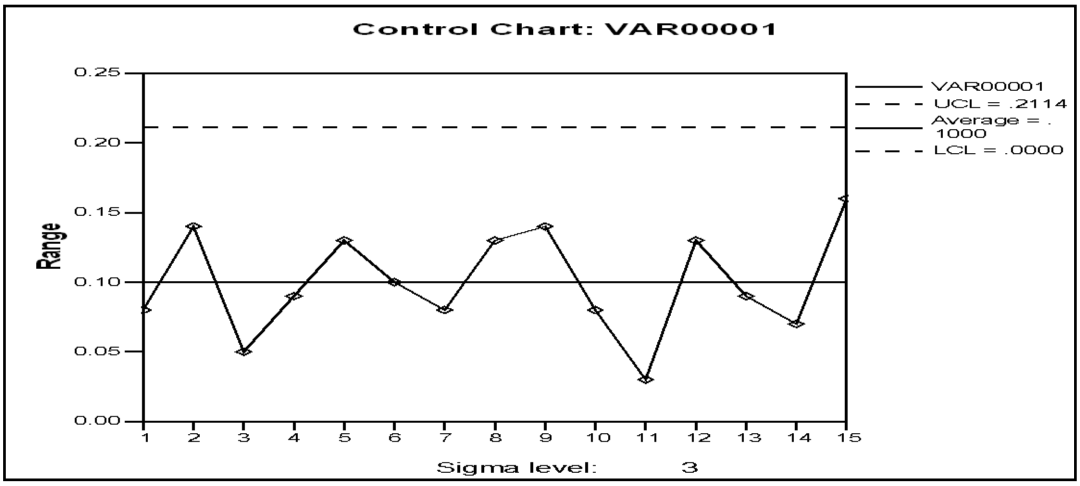


Figure 3: Range control map for the F.F.A. element

We note that all 15 sample readings are within the control limits.

R color element: For the five readings of 15 samples, the arithmetic mean, range and standard deviation were extracted for it, and the limits of the average and range maps were calculated using the same previously mentioned formulas, where the limits of control for the rate map in the form of the number (3) are:

$UCL_{\bar{x}} = 7.735$; $CL_{\bar{x}} = 7.024$ and $LCL_{\bar{x}} = 6.312$

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

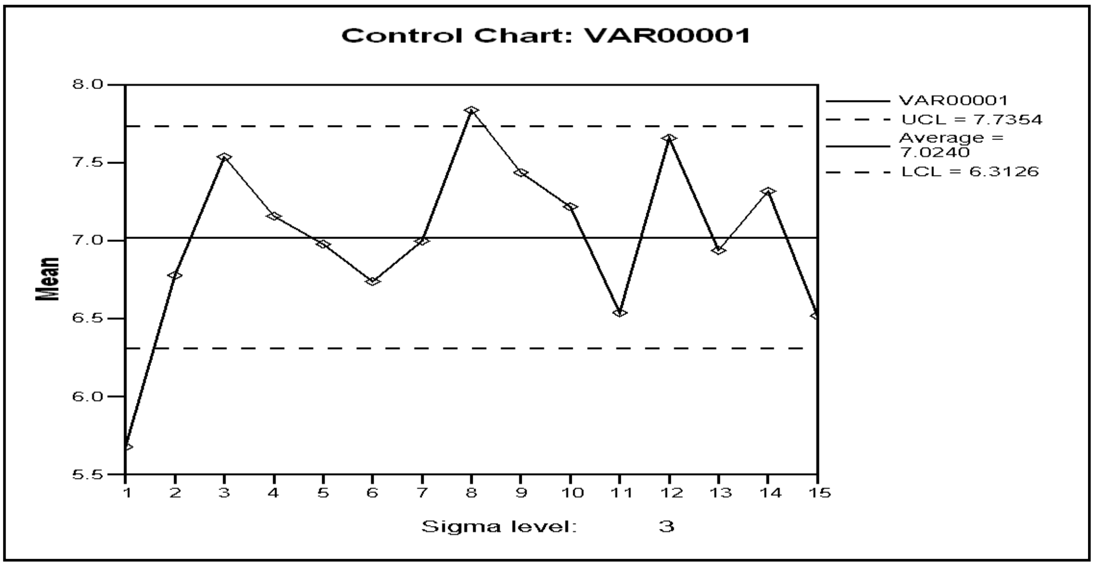


Figure 4: Rate adjustment map for the R element

The control limits for the range map, figure (4), are:

$UCL_R = 2.607$; $CL_R = 1.233$ and $LCL_R = 0$

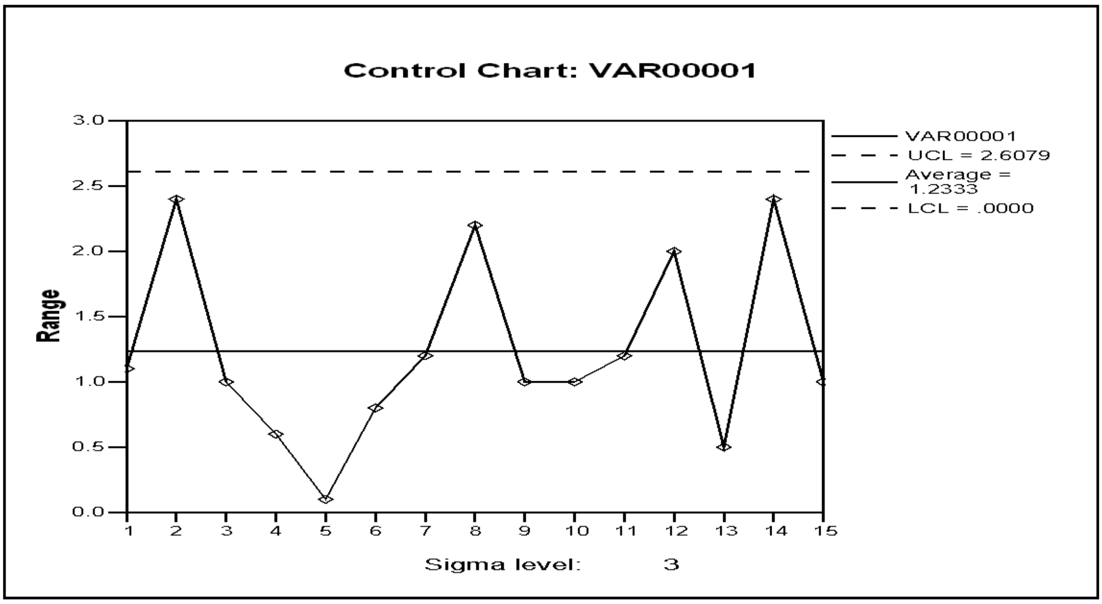


Figure 5: Range setting map for the R element.

We note that the first and eighth samples are outside the control limits of the average map, but in the range map, we note that the readings of all samples are within the control limits of this map.

Fe element: For the five readings of 15 samples, the mean, range and standard deviation were extracted. As for the control limits for the range and average maps, they have been calculated and as follows, where the control limits for the rate map, figure (6), are: $UCL_{\bar{x}} = 1.531$; $CL_{\bar{x}} = 1.193$ **and** $LCL_{\bar{x}} = 0.855$

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

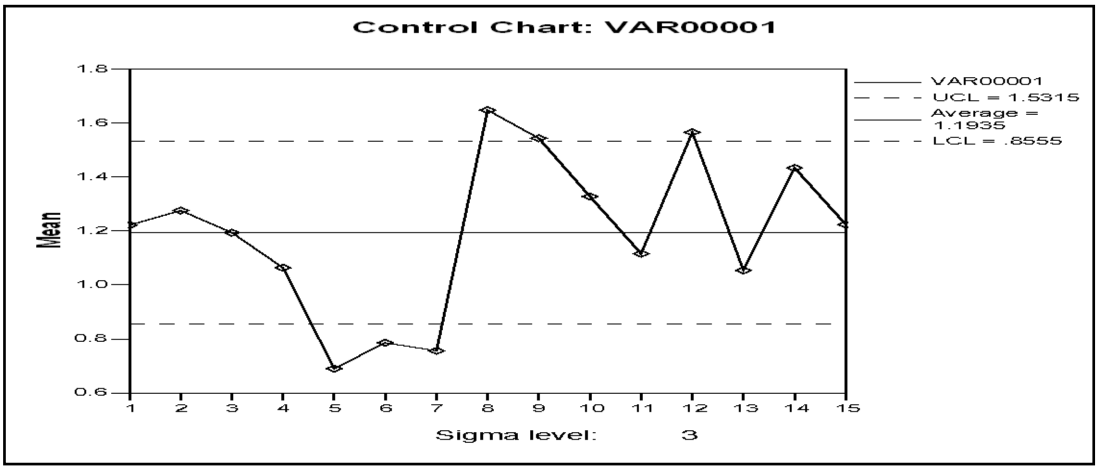


Figure 6: rate setting map for the element Fe.

The limits of control for the range map are Figure (6).

$\mathrm{UCL_R} = 1.239$; $\mathrm{CL_R} = 0.586$ and $\mathrm{LCL_R} = 0$

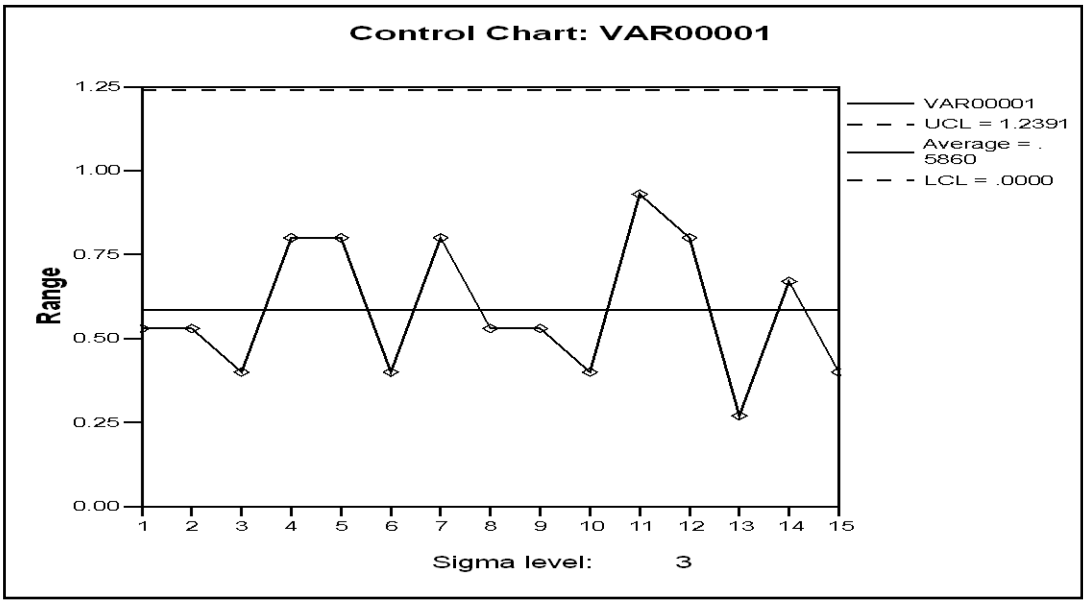


Figure 7: Range mapping of the Fe element.

We notice that there is a large discrepancy in the position of the samples within the control limits of the rate map, as the sample (12, 9, 8, 7, 6, 5) is outside the control limits, but in the range map, all sample readings fall within the control limits, meaning that the production process is dispersed under Adjustments, but there are clear changes in the average value of the production process.

Peroxide element: For the five readings of 15 samples, the arithmetic mean, range and standard deviation were calculated. The control limits were calculated for the rate and range maps, and the control limits for the rate map, figure (8), were:

$\mathrm{UCL}_{\bar{x}} = 1.172$; $\mathrm{CL}_{\bar{x}} = 0.957$ and $\mathrm{LCL}_{\bar{x}} = 0.742$

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

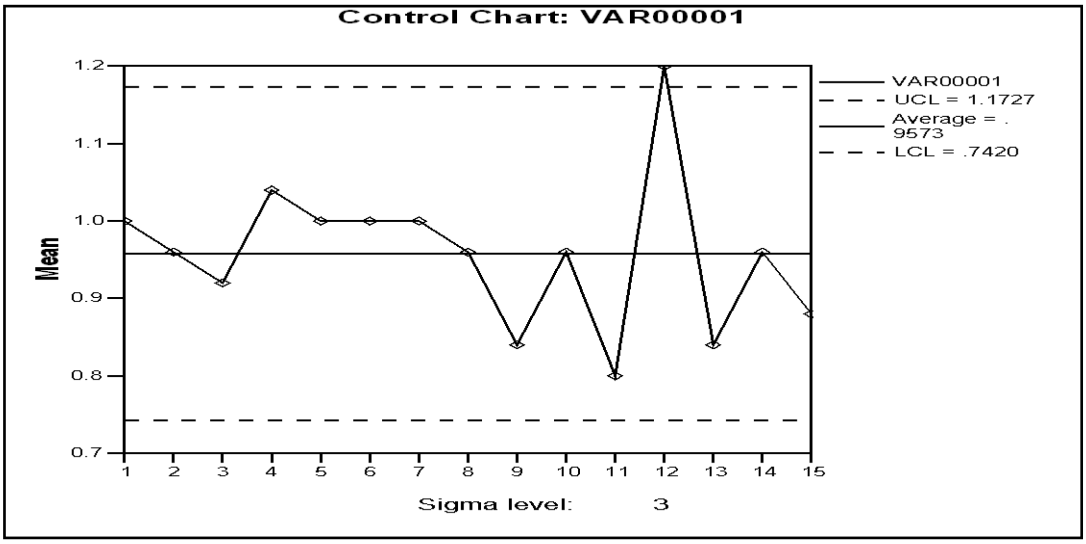


Figure 8: Rate adjustment map for Pr

As for the control limits of the range map, figure (9), they are:

$UCL_R = 0.789$; $CL_R = 0.373$ and $LCL_R = 0$

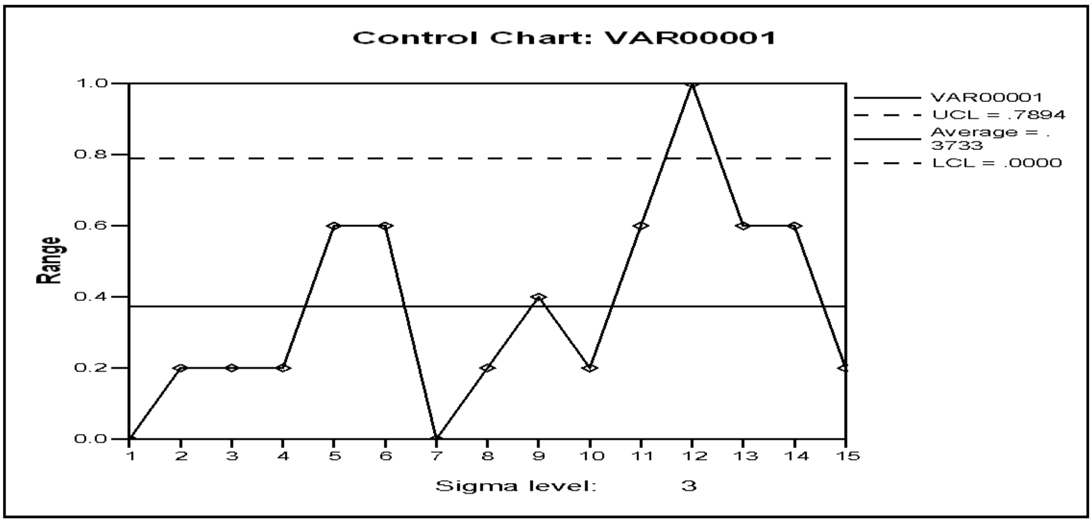


Figure 9: Range setting map for the Pr element.

By observing the rate and range maps, we find that all samples are within the control limits, except for sample No. (12) outside the upper control limits in the two maps, which confirms the existence of a special discrepancy.

From what was mentioned previously, and by looking at the rate and range maps for the four elements mentioned, the reasons that led to the departure of these samples from the limits of control must be studied in order to treat these deviations by removing their causes.

These reasons were identified through the Pareto analysis mentioned in the (analysis stage), and these reasons were also analyzed with a cause-and-effect diagram, and they all represent the causes and results of the deviation of these four elements from the limits of the established specification, and in the end, the production process slows down and the poor quality of the product.

Sixth: The implementation phase of the six-way diffraction project

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

We notice through the previous analysis, especially the statistical control maps, that the upper and lower control limits are within 3σ, and this means that the acceptable error rate is 5%, and the main goal is to reach the absence of errors or what is called the zero defect. The objective This is done by moving from 3σ to 6σ, which leads to the centralization of the production process within the objective set for it and not to be distracted from it. To implement this, the role of the effective administrative leadership comes here, which directly supervises the six-scattering project and in cooperation with the belts, who are the people trained to apply, implement and analyze statistical tools effectively to make appropriate decisions. This is done through:

1. Designing and implementing training courses for all associates, which are called belt courses.
2. Elimination of all causes of defects and interruptions in the production process, which were investigated by the statistician in the previous stages.
3. Design performance measures to analyze the cost of improvement.
4. Introducing modern technology in the factory.
5. Adopting modern administrative principles to create employee loyalty.

And other important administrative activities in order to improve the quality of our national products and in cooperation with the statistician and his method of quantitative and logical analysis of all data to achieve a zero-defect product or service.

6. Conclusions

- The quality control department at Al-Moatasem Factory for Vegetable Oils in Maysan lacks the statistical techniques used in quality control and relies only on laboratory analyzes (which in turn lack modernity) to place the items examined within the limits of their specifications without analyzing the reasons for their deviation.
- The work environment in the whole of this factory is not suitable for advancing the production process and its production quality, as the machine is very old and the building does not meet the requirements of the production process.
- Conclusions of applying the proposed model the six-diffraction methodology in our study sample:
- Sort the customer's voice that there is 61% acceptance of the quality and dissatisfaction with the emitted smell and flavor compared to the imported competing material.
- After measuring the performance ability of the production process (CPK) and the ability of the production process to put production within the required limits (CP), it became clear that:
- FFA Free fatty acids are within limits, but production is inconsistent and the production process is not centralized.
- Fe, the iron element, the calculations indicate that the production process is inefficient and un centralized and the production is not compatible.
- Pr is also an element of peroxide, the production process is inefficient, non-localized, and the production is not compatible.
- R Red The production process is efficient but the production is inconsistent.
- SP The degree of slippage, the calculations indicate that the production process is very efficient and the production is compatible, and that the level of deviation in the long and short term is by the six-dimensional scale, and the error rate in this case is 0.001 in a million.
- The productivity of the sheet section was equal to 79%. This shortcoming in production and obvious and large damage is attributed to poor operating conditions, especially the age of the machine, noting that a new production line is currently being installed.
- Through the analysis using the cause and effect scheme and Pareto analysis, we note that the machine and the worker are close in percentages to cause production variation in the filter and plate sections, while in the packaging department, the highest percentages of causing discrepancy are the work mechanism and the factor because this section depends on the worker, where the work mechanism in this section is represented by % 80 manually due to the lack of modern machines.
- After using the experimental design and analysis of variance, a number of reasons that led to the deviation of the readings of the elements from the limits of their specifications became clear.

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023

- Poor operation, delayed storage, power outages, lack of follow-up and organized monitoring by the worker due to his lack of experience or lack of a sense of responsibility and the poor quality of the raw materials used.
- The most deviant elements were the color R, as the number of readings outside the specification reached (239) times, then followed by the element of fatty acids F.F.A (90) times, then the element of iron (55) times, and finally the element of peroxide Pr (20) times, either repeat. The faults can be summarized as follows:
- Raw material (101), misoperation (88), vacuum breakage (82), power outage (65), boiler malfunction (48), filter paper (20).
- By observing the control maps represented by the two panels of the range and the arithmetic mean of the four elements, the dispersion of the production process is under control, but there are clear changes in the average value of the production process.
- By observing the placement of samples within the control limits of the medium and range plates, there are some of them outside the limits, and this confirms the existence of a special discrepancy.

Funding: "This research received no external funding"

Conflicts of Interest: "The authors declare no conflict of interest."

References

[1] Chernozhukov V, Fernandez-Val I, Galichon A. Improving point and interval estimators of monotone functions by rearrangement. Biometrika 2009;96:559–75.
[2] Duncan AJ. Quality control and industrial statistics 1974.
[3] Fox J. Regression diagnostics: An introduction. Sage publications; 2019.
[4] Aparisi F, García-Díaz JC. A multiobjective optimization for the Ewma and Mewma quality control charts. Inverse Problems, Design and Optimization-Vol 1 2004:130.
[5] AD B. Statistical quality control 1994.
[6] Chakravorty SS. Six Sigma failures: An escalation model. Operations Management Research 2009;2:44–55.
[7] Linderman K, Love TE. Economic and economic statistical designs for MEWMA control charts. Journal of Quality Technology 2000;32:410–7.
[8] Montgomery DC. Introduction to statistical quality control. John Wiley & Sons; 2007.
[9] Ott RL, Longnecker M. An introduction to statistical methods and data analysis. Cengage Learning; 2016.
[10] Pande PS, Neuman RP, Cavanagh RR. The Six Sigma way team fieldbook: an implementation guide for project improvement teams. McGraw-Hill; 2002.
[11] Kabir ME, Boby S, Lutfi M. Productivity improvement by using Six-Sigma. International Journal of Engineering and Technology 2013;3:1056–84.
[12] Park SH. Six Sigma for quality and productivity promotion. Japan:Asian Productivity Organization 2003.
[13] Peddada S Das. Confidence interval estimation of population means subject to order restrictions using resampling procedures. Statistics & Probability Letters 1997;31:255–65.
[14] Ryan TP. Statistical methods for quality improvement. John Wiley & Sons; 2011.
[15] Strand M, Zhang Y, Swihart BJ. Monotone nonparametric regression and confidence intervals. Communications in Statistics—Simulation and Computation® 2010;39:828–45.
[16] Taguchi G. On-line quality control system designs. Statistical Process Monitoring and Optimization, CRC Press; 1999, p. 21–38.

Doi: https://doi.org/10.54216/PMTCS.030201
Received: June 21, 2023 Revised: September 05, 2023 Accepted: December 07, 2023