Assessing the quality of Product using statistical quality control maps: a case study"

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Receiving Date: 2010/5/11 **- Accept Date:** 2011/10/30

خلاصه البحث

يهدف البحث الى تقييم جوده الانتاج في احدي معامل الالبان اذا تم سحب (15) عينه من انتاج هذا المعمل خلال اسبوعين متتالين وكل عينه تضمنت (3) عبوات من منتج المعمل . تم اعداد خريطه مراقبه جوده الانتاج للمتوسط لمنتج المعمل باستخدام (R-bar) و (X-bar) والانحراف المعياري المشترك التجميعي pooled standard deviation . اوضحت خريطه مراقبه جوده الانتاج لمنتج المعمل ان الانتاج لايسير وفقا لمواصفات الجوده المحدده من جانب اداره المعمل حيث وجد ان العينه رقم (13) قد تجاوزت الحد الادني للمراقبه. كما و يهدف البحث في ان يكون عونا للعاملين في مجال جوده الانتاج في تاديه عملهم بكفائه وفاعليه .

Keyword: Quality, Quality Control map, statistical quality control maps.

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Abstract

Statistical process control (SPC) involves measurements of process performance that aim to identify common and assignable causes of quality variation and maintain process Performance within specified limits. it is fashionable buzzword in manufacturing industry.

Manufacturing organizations need to improve quality while decreasing costs and increasing production volumes with fewer resources. [1] As competitive pressure has been steadily rising. These studies aimed to assess production quality in the plant, in this research we have about (15) sample of product in 2 weeks each one content 3 sub sample. We apply the (R-bar), (S-bar) &pooled standard deviation. [2], [3], [4] [5] analyzing data collection by using MINTAB present that the production did not mach the specification that the plant management wanted to achieve. The underlying goal of the study is to reduce the variations and rejections in a critical process. The objective of this paper is to monitoring the quality of Product using statistical quality control maps; explain the concept of statistical process control and its application in a manufacturing industry to improve the quality levels. [6]

Introduction

Quality is a key factor for the survival of the organization in the business environment. So it became necessary for industrial plants and laboratories quest for continuous improvement in performance in order to meet the requirements and international standards in the quality of production.

Quality Control charts are commonly used in production environments to analyze process parameters to determine if a controlled process is within or out of control, i.e. to distinguish between assignable and common, also called chance, causes. Control charts are valuable for several purposes throughout the process improvement cycle.

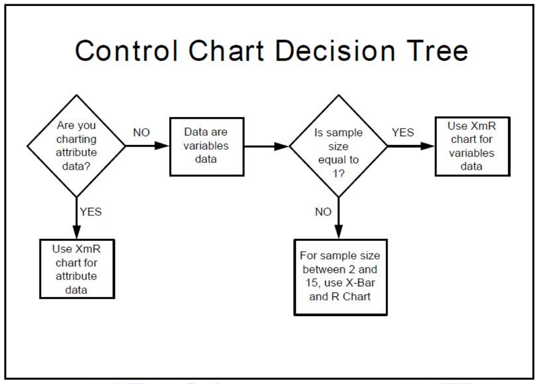

Fig. (1) Control chart Decision Tree

These uses are described and illustrated in greater detail elsewhere and include Testing for and establishing a state of statistical control; Monitoring an in-control process for changes in process and outcome quality; Identifying, testing, and verifying process improvement opportunities.

we depend Four steps to develop control charts first Step Gather data Step two we Calculate control limits and after that Interpret for process control final step was Interpret for process capability . [7], [8], [9], [10]

It is a statistical tool used to distinguish between variation in a process resulting from common causes and variation resulting from special causes. It presents a graphic display of process stability or instability over time._Quality Control and style of a statistical tool to monitor the production process to match the specifications and preset find weaknesses and undesirable deviation in performance with that identify the causes of deviations and take corrective action to avoid failure in the future, which guarantees continuous improvement. Some manufacturing processes which benefit from control chart tracking are filtration, extraction, fermentation, distillation, refining, reaction, pressing, metal cutting, heat treatment, welding, casting, forging, extrusion, injection molding, spraying, and soldering .[11] , [12] , [13], [14]Control charts used for Differentiate between special cause and common cause variation, Assess the effectiveness of changes to improve a process, communicate how a process performed during a specific period. Although computationally simple, control charts are sometimes complex to use correctly because the sample points come from non-specified probabilistic distributions and usually require interpretation by a skilled user. Using the statistical software package ready-made maps in the implementation of quality control because it easy to understand and action in the interpretation of results. [15], [16], [17], [18]

X bar and R chart is a two-part Control Chart used to monitor processes with variable type data. In general, variable data requires some form of measurement, e.g., length, temperature, time, volume, pressure, etc. [19] Before the decision on the level of quality in the production process in the sense we are conforming or not conforming to the specifications it was incumbent on the decision maker to define the concept of non-conformity of the production process to the specifications of the required quality depending on the nature of the phenomenon under study as show in Fig (2).

The production process which does not match the specifications in the case of points located at a lower level than the minimum to the monitoring points, while the presence of a higher level of the upper limit of for observation, its good and needs to be consolidated.

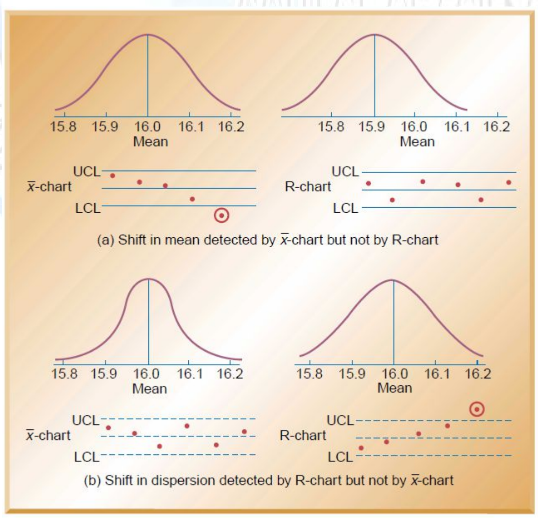

Fig (2) Process shifts captured by –charts and R-charts

Need of SPC

Statistical process control (SPC)[2] is meant to control the product quality on-line so that the product conforming to specifications is produced. To be truly effective, SPC must become an important segment of corporate life as a part of total quality control program. SPC is strongly needed due to following reasons:

a) To discover when a process is out of control so that corrective action is taken well in time.

b) To reduce the cost of internal failures, i.e. scrap and rework.

c) To ensure that operators are paid only for good quality production.

d) To eliminate frequent readjustments and interruptions in the process which would otherwise result in production loss and greater variability in product quality?

e) Better utilization of labor, facilities and material. [20]

f) Data obtained from SPC can be used to determine whether the given process has the potential or capability of meeting the specifications on various quality parameters. If not, we can undertake a number of remedial actions to minimize the production of non-conforming product. [21], [22], [23], [24]. Statistica1 quality control (SQC) is the term used to describe the set of statistical tools used by quality professionals. Statistical quality control can be divided into three broad categories: [25], [26], [27], [28], [29]

1. Descriptive statistics are used to describe quality characteristics and relationships. Included are statistics such as the mean, standard deviation, the range, and a measure of the distribution of data.

2. Statistical process control (SPC) involves inspecting a random sample of the output from a process and deciding whether the process is producing products with characteristics that fall within a predetermined range. SPC answers the question of whether the process is functioning properly or not.

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[3] SPC= STATISTICAL PROCESS CONTROL

2

3. Acceptance sampling is the process of randomly inspecting a sample of goods and deciding whether to accept the entire lot based on the results. Acceptance sampling determines whether a batch of goods should be accepted or rejected.

Control chart was invented in the Bell Labs by Walter Shewhart on May 24, 1924 [7].Graphically represented by plotting process parameter against time, control chart is intended to monitor process stability and variability [6] [10].

unit3	unit2	unit1	sample No.
101.3	99.2	104.4	1
93.7	98.1	92.9	2
98.7	92.5	92.3	3
99.4	102.2	101.6	4
90.0	99.1	97.4	5
90.4	92.5	102.2	6
104.5	103.2	98.4	7
104.0	95.9	90.0	8
101.8	102.3	97.6	9
104.9	103.1	91.6	10
101.6	94.8	101.7	11
102.4	92.5	104.5	12
92.7	90.7	91.5	13
95.7	91.4	97.2	14
94.7	104.4	99.0	15

Table (1) Data Collection

The graph includes a Centre Line, an Upper Control Limit and a Lower Control Limit. Control chart is one of the most important SQC methods in quality control and improvement. [30], [31] , [32] , [33] , [34] It is a proactive statistical tool intended to monitor Processes and signal when they go out of control.

Control Maps for the number of units attributed to faulty or defective units, we find that the standard non-conformity is limited to the points that fall in the level higher than the minimum limit check. Community is well known that the average (μ) is equal to 100 grams the standard deviation of the society (σ) is unknown.

A case study

A study was conducted in a plant which product food product from whole milk (derivative). The plant is accredited with ISO 9001 and QS 9000 quality standards. The plant has more than 70 employees and it located in Iraq. Major customers of the plant in different section society, it has separate quality assurance department.

METHODOLOGY

Aim

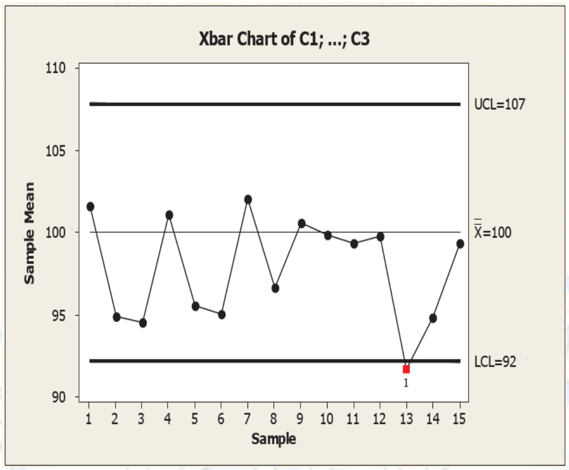
These studies aimed to assess production quality in the plant, We apply the (x -bar) , (R -bar) &pooled standard deviation. analyzing data collection by using MINTAB present that the production did not mach the specification that the plant management wanted to achieve .

Sample and data collection

In this research we have about (15) sample of product during two weeks period in 2010, each one content 3 sub sample. Tables (1) present the Data collection which has been collected from the plant which have many products, the researcher find that the main product for this plant was (cheese) weight (100) Gram.

Data analysis by Minitab

For analyzing we use Minitab software to monitor the data by statistical quality control maps, two methods used (R-bar) and (x-bar).



Fig(3) X-bar Chart of Data collected

By using Range (R) charts or (R-bar) control chart for variables. Whereas x-bar charts measure shift in the central tendency of the process, range charts monitor the dispersion or variability of the process. [35], [36], [37], [38]

The method for developing and using R-charts is the same as that for x-bar charts. The center line of the control chart is the average range, and the upper and lower control limits. [39] ,[40], [41]

Quality Control map showing that production in the laboratory which does not go according to quality standards set by the management of the plant as the sample (13) has exceeded the minimum of control.

Sample Size (n)	$\bar{X}$ – Chart	R - Chart	
	A_2	D_3	D_4
2	1.88	0	3.27
3	1.022	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78
11	0.29	0.26	1.74
12	0.27	0.28	1.72
13	0.25	0.31	1.69
14	0.24	0.33	1.67
15	0.22	0.35	1.65
16	0.21	0.36	1.64
17	0.20	0.38	1.62
18	0.19	0.39	1.61
19	0.19	0.40	1.60
20	0.18	0.41	1.59

Table (2) factor for x-chart

We calculate the Mean, Standard deviation, range. The CL = μ in this case study and its equal to 100. The value of UCL will be calculated as:

UCL = μ + A 2 R (100+ 1.022* 76.67) , n=3 , LCL =(100 - 1.022 76.67).

for n=3 the value for factor for x-chart = 1.022 as showed in Table (2) .

we also use S – bar and calculate CL= μ =100 , UCL= μ + 3n / √n(100*3*40.3) , LCL = μ - 3n / √n(100*3*40.3).

After that we calculate Pooled Standard Deviation as:

$$UCL = \mu + \left(\frac{3\,(S)\;pooled}{\sqrt{n}} \right)$$

$$(S)pooled = \sqrt{\frac{(n-1)\left(S_1^2 + S_2^2 + \dots\dots\dots + S_k^2\right)}{K(n-1)}}$$

$$UCL = \mu - \left(\frac{3\,(S)\;pooled}{\sqrt{n}} \right)$$

Worksheet 1 ***

↓	C4 Mean	C5 Standard Deviation	C6 Range
1	101	26.1598	52
2	94	28.0000	52
3	94	36.3868	64
4	101	14.7422	28
5	95	48.3839	91
6	95	62.9471	118
7	102	32.1299	61
8	96	70.2875	140
9	100	25.8134	47
10	99	72.1549	133
11	99	39.5517	69
12	99	64.0859	120
13	91	10.0664	20
14	94	30.1054	58
15	99	48.6038	97

Table. (3) Mean, Standard Deviation& Range

Results & Conclusions

1- Our results show that the statistical process control is an effective means for controlling and improving the process quality. Critical variables i.e weight was selected on the basis of rejections due to them. With the application of variable control charts, significant improvement has been experienced in terms of process capability.

UCL	CL = μ	n	Factor for X-Chart	LCL
107	100	3	1.022	92.16

Table (4) weight variable statistical process

2- The study shown , generally, the adaptive X-bar , R-bar chart are able to improve the effectiveness .

3- our study also present that Quality Control map which does not go according to quality standards set by the management of the plant as the sample (13) has exceeded the minimum of control as show in Fig (1).

4- The study presents determine the quality characteristic to be controlled or monitored. Than take an adequate number of samples to establish a baseline. And choose the appropriate control chart for plotting data. final Compute mean line and control limits. and establish a location to display the control chart. as show in fig(2), Train operators to plot and interpret the chart. Collect data using samples at defined intervals or frequencies. Plot data on control charts. Analyze the results for each sample. Interpret the results and take necessary action.

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