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Contemporary Quality Management Control Chart

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Abstract: Quality always has been an integral part of virtually all products and services. It is continuously meeting exceeding customer and supplier needs, requirements and expectations in all aspects. However, our awareness of its importance and the introduction of formal methods for quality control and improvement have been an evolutionary development. This article present Core concepts of contemporary quality management Quality Control techniques Control Chart to measure, analyze and control quality by continuously monitoring, controlling and managing process maintaining sampling to continuously Improvable targets by continuously producing and offering services within low and lower Percentage Defectives in meeting exceeding customer and supplier needs, requirements and expectations. Sampling, Sample size and sample numbers of Proportion of population covered with sampling Rational sub group, are two basic for quality monitoring and control to manage quality of products as well as services within Continuously improving tolerable number and/or Percentage Defectives. To monitor the quality characteristics of a process, appropriate Control chart used in quality management capable of showing the evolution over time of the behavior of the quality characteristics and detecting situations that seem to present certain anomalies must be used. Thus, This Article deals with the application of selected Quality Management and propose Control chart based on Sample size and sample numbers of sampling Rational sub group and Proportion of population covered with γ% Confidence of sample size n to monitor process using number of defectives, through which we can achieve continuous quality improvement. In this paper, Control chart involves using statistical and mathematical techniques were used to measure and analyze the variation in processes intent to monitor product quality and maintain processes to fixed targets. this article show how to use proposed control charts to monitor discrete data and present the assumptions behind the charts, their application, and their interpretation to measure, analyze and control quality by monitoring and managing quality maintaining processes to continuously Improvable targets to manufacture a product as designed within low and lower Percentage Defectives. The advantage of these tools is that they can identify the effects of the processes that cause unnatural variability in processes that result of Defectives and poor quality in offering services within low and lower Percentage Defectives in meeting exceeding customer and supplier needs.

Keywords: Quality, Defectives, Control Chart, Management, Sampling, Tolerance

1. Introduction

Quality always has been an integral part of virtually all products and services. In popular use of quality gurus and experts in the field, the word Quality is meeting customer requirements. However, this is too imprecise and limited idea of quality to be of any use. Quality can be defined in many ways, ranging from “satisfying customers’ requirements” to “fitness for use” to “conformance to requirements” (MONTGOMERY, Sixth Edition) [13]. It is obvious that any definition of quality should include both customers and suppliers, satisfying whom must be the primary goal of any business. Because what is continuously seen and added by the supplier since valuably important in continuously meeting exceeding needs, requirements and expectations may be very different from the expected concerns of the customer. Thus, with respect to Quality Gurus:

Quality is supplier continuous experience with the product as well as services, measured against requirements-stated or unstated, conscious or merely sensed, technically operational or entirely subjective aimed at continuously meeting exceeding present and future needs, requirements and expectations of customer and supplier.

Customers and suppliers quality priorities may be very different. Suppliers' quality priorities are producing non defectives profitable products which customer can buy satisfactorily. Profitability is suppliers' need whereas customers ability and capability to use products effectively for functions it produced appropriately is suppliers requirement. Thus, Quality service is production of product or offering service which fulfills exceeding an aggregate needs, requirements and expectations of both customers and suppliers, in all aspects.

Experience during the last two decades in the U.S. and world markets has clearly demonstrated that quality is one of the most important factors for business success and growth [13]. However, our awareness of its importance and the introduction of formal methods for quality control and improvement have been an evolutionary development. It is true, The 1970s made one thing abundantly clear: a quality advantage could lead to improved market share and profitability [14]. Thus managing quality is a priority for business profit and success.

Quality control is essential activities and techniques employed at the point of operation or production to continuously monitoring, controlling and managing process to Improve and exceed the quality level of a product, process, or service [10]. To monitor the quality characteristics of a process, appropriate graphical and statistical tools must be used. These tools are capable of showing the evolution over time of the behavior of the quality characteristics (measurable or countable) and detecting situations that seem to present certain anomalies. The control chart is one of these tools widely used in quality management. Control chart involves using statistical techniques to measure and analyze the variation in processes intent to monitor product quality and maintain processes to fixed targets. Control Chart is used to monitor the consistency of processes used to manufacture a product as designed. It aims to get and keep processes under control maintain processes to fixed targets within allowable Percentage Defectives.

Quality management mean continuously improving the quality of everything, i.e. creating a high and higher quality company; high and higher quality man, machine, material, methods, management and information in continuously satisfying exceeding customers and suppliers present and future need, requirement and expectation by operating within low and lower Percentage Defectives [11]. Whereas, Quality control is essential activities and techniques employed at the point of operation or production to continuously Improve and exceed the quality level of a product, process, or service. It includes a monitoring activity, but is also concerned with continuously finding and eliminating causes of quality problems so that the requirements are continuously Improved and met. This article aims to present the general concept of Quality management and Core concepts of Quality control techniques to measure, analyze and control quality within low and lower Percentage Defectives.

Good quality management requires quality actions to be planned out, improved and controlled. Statistical quality control provides the statistical techniques necessary to assure and improve the quality of products. The purpose of quality control is to ensure, in a cost efficient[1] manner, that the product shipped to customers meets their specifications. During the last century, control charts was introduced by Dr. Walter Shewart in 1924 at Bell Laboratories aimed at helping us to decide how to react, right now, in response to the most recent information about the process shown in the charts [1] [12]. The control chart is a very useful process monitoring technique; when unusual sources of variability are present, sample averages will plot outside the control limits. This is a signal that some investigation of the process should be made and corrective action to remove these unusual sources of variability taken. Control charts will place information onto the chart information which tell us about things we should do, and also about things we should refrain from doing [12]. Aimed at techniques necessary to assure and improve the quality of products, This Article set of methods for monitoring process characteristics over time called control charts and places these tools in the wider perspective of quality improvement maintaining processes to continuously Improvable targets to manufacture a product as designed within low and lower Percentage Defectives.

Moreover, The use of the appropriate control chart will serve to accomplish the objective for which it was invented, the economic[2] control of quality [16]. Aimed at helping us to decide how to react, right now, in response to the most recent information about Number of defects of the process, This article present the general concept of Quality and Core concepts of Quality control Chart techniques to measure, analyze and control quality by monitoring and managing quality maintaining processes to continuously Improvable targets to manufacture a product as designed within low and lower Percentage Defectives.

2. Analysis and Result

Currently, many scholars and quality practitioners and controller are measuring if or weather process is in control for incapable process by measuring distribution of number of observed defectives data. They are measuring and monitoring processes on which control limit of data with sample size n and sample number m directly doubled if number of defectives of data doubled and both processes data are treated as in control as if both processes are producing products with in allowable Percentage Defectives. For instance, figure below shows control chart of sample data of two processes with doubled number of defectives for the same number of sample size (50) and Sample number (10) where both process are in control with doubled control limit value proportional to defectives.

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[1] Inspecting every product is costly and inefficient, but the consequences of shipping non-conforming product can be significant in terms of customer dissatisfaction.

[2] The economy referred to is the balance of the two mistakes one can make in deciding the fate of a process on the basis of a sample. Either mistake bears with it the risk of tampering.

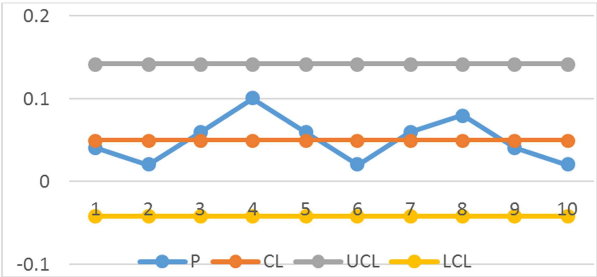

Figure 1. *Control chart for defectives data I.*

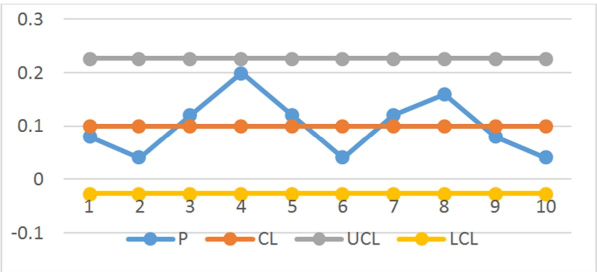

Figure 2. *Control chart for defectives data II.*

Note: Percentage Defectives of both processes are 0.05 and 0.1 which doubled as number of defectives double. Since they are monitoring defectives distribution in relation to control limit doubled or tripled as number of defectives doubled or tripled, they forget to compare with allowable defectives that meet permissible Percentage Defectives for sample size n and sample number m of sampling.

Moreover, if we look at example proposed by Montgomery, Introduction to Statistical Quality Control, Sixth Edition; John Wiley & Sons, Inc.; Arizona State University, EXAMPLE 7.1: Construction and Operation of a Fraction Nonconforming Control Chart, page-293 on Frozen orange juice concentrate is packed in 6-oz cardboard cans to Set up a control chart to improve the fraction of nonconforming cans produced by this machine. To establish the control chart he use 30 samples of n=50 cans each were selected at half-hour intervals over a three-shift period in which the machine was in continuous operation. According to the data shown in Table 7.1 of (MONTGOMERY, Sixth Edition), Number of non-confirming can are 347 and thus, Percentage Defectives for sample size 50 and sample number 30 of sampling will be 0.2313 percentage of defectives which is less than 1 process capability on which we can progress to monitor process if or whether process is in control or not [3].

Sampling, Sample size and sample numbers of Proportion of population covered with sampling Rational sub group, which shall be determine by Costs and time required are two basic for quality monitoring and process control to manage quality of products and services so that we can manage Quality let alone quantity of product is one factor which determine Sampling of Rational sub group [9]. The amount of defective items in a manufacturing process can be monitored using statistics based on the observed number of defectives in a random sample of size from a continuous manufacturing process, or from a large population or lot.

It is true, As number of product sampled increase number of defective products in relation to sample size increase. Thus, Sampling with lower number of Sample numbers of Rational sub group should produce lower number of defective products in relation to sample size whereas Sampling with higher number of Sample numbers of Rational sub group can have higher number of defective products in relation to sample size. Moreover, as quantity of sample size increase number of permissible defective products should decrease logarithmicly. Because variation in production of specified sample is low and expected quality level should be high and number of defective products in relation to sample size must be low to attain and assure quality level we must meet and exceed expectation within Proportion of population covered. Hence process capability is more than one and increase as sample size increase.

The purpose of any control chart is to help you understand your process well enough to take the right action. This degree of understanding is only possible when the control limits appropriately reflect the expected behavior of the process. When the control limits no longer represent the expected behavior, you have lost your ability to take the right action [10]. Therefore, control limit of control chart of number of defectives[3]:

$$D = Log_{n}^{Ns} \qquad (1)$$

Where

D- number of permissible defectives

Ns- total number of product sampled which is n*m

n- sample size

m - sample numbers

We can say process is in control if number of defectives of sampling Rational sub group is less than or equal to number of permissible defectives of sampling. Based on mutual understanding tolerance can be added mainly to decade and set upper control limit which shall be determined by customers suppliers agreement based on Proportion of population covered with ɣ% Confidence of sample size n. The proportion defective in a sample of Rational sub group follows the binomial distribution where is the probability of an individual item being found defective with ɣ% Confidence of sample size n should be determined based on Proportion of population covered with sampling Rational sub group using Tolerance Interval Factors Table. Thus, Process must be in control and produce products at list with three ɣ% Confidence of sample size n from Mean or control limit. Thus upper and lower control limits of control chart must be:

$$D \pm 3 * I \qquad (2)$$

Where: I is number of tolerable defectives with ɣ% Confidence of sample size n

[3] Note: sample size is base where as number of sampled is factor of quality control logarithm function. Mean or control limit of control chart of number of defectives should be number of permissible defectives of sampling.

Thus
$$UCL = D + 3 * I$$
$$CL = D$$
$$LCL = D - 3 * I$$

Control Charts are Decision-Making Tools. They provide an economic basis for deciding whether to alter a process or leave it alone and Control Charts are Problem-Solving Tools, they provide a basis on which to formulate improvement actions. Questions of interest for quality control are:

1. Is the process is Capable producing product with less and lower percentage of defectives?
2. Is the number of defective of Proportion of population covered with sampling Rational sub group items are within prescribed limits?
3. Is the number of defective items meets customer tolerable prescribed limit requirement and the product produced of samples shall be tolerated and accepted by customers?

Let us see this example

Example: table below show number of defectives (d) of Samples data of 20 Sample number with 90% Confidence of 200 sample size of Proportion of population covered with sampling Rational sub group to monitor process using number of defectives control chart where Sn is sample numbers and d is number of defectives.

n	ϒ=0.90	ϒ=0.95	ϒ=0.99	ϒ=0.995
2	0.052	0.026	0.006	0.003
4	0.321	0.249	0.141	0.111
6	0.490	0.419	0.295	0.254
10	0.664	0.606	0.496	0.456
20	0.820	0.784	0.712	0.683
40	0.907	0.887	0.846	0.829
60	0.937	0.924	0.893	0.883
80	0.953	0.943	0.920	0.911
100	0.962	0.954	0.936	0.929
150	0.975	0.969	0.957	0.952
200	0.981	0.977	0.968	0.961
500	0.993	0.991	0.987	0.986
1000	0.997	0.996	0.994	0.993

Figure 3. *Tolerance Interval Factors (Pyzdek, 2003).*

Table 1. *Number of defectives data.*

Sn	d	Sn	d	Sn	d	Sn	d
1	1	6	2	11	2	16	4
2	3	7	1	12	4	17	2
3	4	8	3	13	3	18	1
4	2	9	5	14	1	19	3
5	1	10	3	15	3	20	2

Sample Number m=20Sample size n=200

total number of product sampled Ns=m * n=4,000

number of permissible defectives D is:

$$D = Log_{200}^{\;4,000} = 1.56541201$$

Note: with 1.56541201 number of permissible defective expected process capability (Cp_E) is approximately 1.3 with 0.007827percentage of defectives which is more than data process capability (Cp_d) of 1.2 with 0.0125 percentage defectives. thus tolerance is required as per agreement and For 90% Confidence of 200 sample size I=0.981 from Tolerance Interval Factors [2].

Thus, Control limits of control chart are:

CL=1.565;

UCL=4.5084;

LCL=-1.37758799

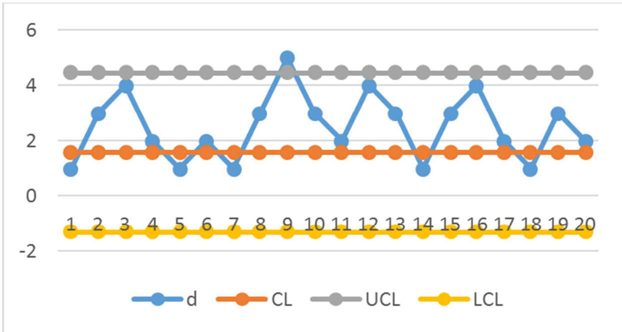

Figure 4. *Control chart of number of defectives data.*

The proportion defective of Proportion of population covered with sampling Rational sub group in a sample follows the binomial distribution where is the probability of an individual item being found defective. With 90% Confidence of 200 sample size tolerated process capability (Cp_t) is less than 1.2 with 0.02254206 percentage of defectives which is less than data process capability Cp_d of 1.2. Thus, we can say that the process is capable even though their is out of control sample with out of control number of defectives data.

Moreover, with defectives tolerance of 90% Confidence of 200 sample size:

1) Five samples of data produce defectives less than number of permissible defective, Hence process at that samples meet customer requirement satisfactorily and the product produced of that sample shall be accepted by customers.
2) Hence sample of sample number 9 produce defectives more than number of Tolerable defectives, process is out of control to meet customer tolerable requirement and the product produced of that sample shall be rejected by customers.
3) Note: for sample of sampling Rational sub group with out of tolerable requirement control limit, products produced of that sample meeting customer need can be accepted by customers after 100% sampling.
4) The rest 14 samples produce defectives more than number of permissible defective but less than number of Tolerable defectives, hence process is in control to meet customer tolerable requirement and the product produced of samples shall be tolerated and accepted by customers as per their agreement.

Note: for samples of sampling Rational sub group within upper tolerable control limit,

a) products produced of samples shall be tolerated and accepted by customersif Cp_d>Cp_t since data gives lower percentage defectives.

b) products produced of samples may be fully accepted by customers based on C of new sample after re-sampling samples using Proportion of population covered with sampling Rational sub group if Cp_d=Cp_t since data must be checked for lower percentage defectives.
c) products produced of samples meeting customer need can be accepted by customers after 100% sampling if Cp_d<Cp_t since data gives higher percentage defectives.

3. Discussion

Quality always has been an integral part of virtually all products and services [2]. It is continuously meeting exceeding customer and supplier needs, requirements and expectations in all aspects. However, our awareness of its importance and the introduction of formal methods for quality control and improvement have been an evolutionary development. More recently, organizations have changed their approach to quality management, and moved the emphasis from inspections at the end of production, to focus on the operations during the process itself, to make sure no defects are made and to the planning stages, to make sure the design of the product and the process allow high quality [4]. Now, quality management is no longer a separate function concentrating on the later parts of a process, but an integral part of the process, concentrating on the earlier parts. In effect, operational departments have taken responsibility for their own quality.

Good quality management requires quality actions to be planned out, improved and controlled [6, 8]. The control chart, though originally developed for quality control in manufacturing, is applicable to all sorts of repetitive activities in any kind of organization. They can be used for services as well as products, for people, machines, cost, and so on. However, Most of the statistical quality control techniques used now have been developed during the last century [5, 7]. The choice of the control charts is vital and every person practicing total quality should know their appropriate usage. Inept selections can be disastrous and can affect the decision-making processes. As objectives, this article show how to use control charts to monitor discrete data and present the assumptions behind the charts, their application, and their interpretation to measure, analyze and control quality by monitoring and managing quality maintaining processes to continuously Improvable targets to manufacture a product as designed within low and lower Percentage Defectives.

Scholars are saying Percentage Defectives for Different Values of Cp and Cpk for Smaller-the-Better and process with less than one Cp is in capable. Whereas currently many scholars and quality practitioners and controller are measuring if or weather process is in control for incapable process with high Percentage Defectives. For instance to say process is capable with at list Cp=1 Percentage Defectives must be less than 0.135. moreover, they are only monitoring process if or weather in control based on observed defectives data rather than permissible number of defectives in relation to sample size n and sample number m of Proportion of population covered with sampling Rational sub group. As per their analysis number of defectives control chart measure uniformity of ratio of number of defectives per sample size across sample numbers. Hence for process producing products far from allowable number of defectives having uniformly banched banch of defectives are treated as in control.

Sampling, Sample size and sample numbers of Proportion of population covered with sampling Rational sub group, are two basic for quality monitoring and control to manage quality of products as well as services within Continuously improving tolerable number and/or Percentage Defectives as per customers and suppliers agreement so that organizations can manage Quality satisfying exceeding customers and suppliers need, requirement and expectation. Mutual agreement of customers and suppliers on sampling, Sample size and sample numbers, and on ɣ% Confidence of sample size n of Proportion of population covered with sampling Rational sub group determine control chart control limits and hence permitable and Tolerable number of defectives of Rational sampling group quality level so that process can be monitored if or weather capable and in control to produce product as designed exceeding allowable Percentage Defectives and product can be accepted, re-sampled or rejected based on Cpd, Cpt and sample C.

Thus, This article present the general concept of Quality control and Core concepts of monitoring process characteristics over time called control charts and places these tools in the wider perspective of quality improvement maintaining processes to continuously Improvable targets. A typical control chart proposed gives a bird‘s eye-view graphical display of a quality characteristic that has been measured or computed from a sample versus the sample number gives the basis for selecting these charts.

4. Conclusion

This article present Core concepts of contemporary quality management Quality Control techniques Control Chart to measure, analyze and control quality by continuously monitoring, controlling and managing process maintaining sampling to continuously Improvable targets by continuously producing and offering services within low and lower Percentage Defectives in meeting exceeding customer and supplier needs, requirements and expectations. Sampling, Sample size and sample numbers of Proportion of population covered with sampling Rational sub group, are two basic for quality monitoring and control to manage quality of products as well as services within Continuously improving tolerable number and/or Percentage Defectives. To monitor the quality characteristics of a process, appropriate Control chart used in quality management capable of showing the evolution over time of the behavior of the quality characteristics and detecting situations that seem to present certain anomalies must be used.

This article present the general concept of Quality control and Core concepts of monitoring process characteristics over time called control charts and places these tools in the wider perspective of quality improvement maintaining processes to continuously Improvable targets. This Article deals with the application of selected Quality Management and propose Control chart involves using statistical and mathematical techniques based on Sample size and sample numbers of sampling Rational sub group and Proportion of population covered with ɣ% Confidence of sample size n to monitor process using number of defectives, through which we can achieve continuous quality improvement. In this paper, Control chart proposed was used to measure and analyze the variation in processes intent to monitor product quality and maintain processes to fixed targets and identify the effects of the processes that cause unnatural variability in processes that result of Defectives and poor quality in offering services within low and lower Percentage Defectives in meeting exceeding customer and supplier needs.

Moreover, Good quality management requires quality actions to be planned out, improved and controlled. The process achieves control at one level of quality performance, and then plans are made to improve the performance on a project-by-project basis, using tools and techniques such as Control chart. This activity eventually achieves breakthrough to an improved level, which is again controlled, to prevent any deterioration. this article show how to use proposed control charts to monitor discrete data and present the assumptions behind the charts, their application, and their interpretation to measure, analyze and control quality by monitoring and managing quality maintaining processes to continuously Improvable targets to manufacture a product as designed within low and lower Percentage Defectives. Systematic use of this control chart is an excellent way to monitoring activity concerned with continuously finding and eliminating causes of quality problems and reducing variability in meeting exceeding customer and supplier needs.

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