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PROCEDURE TO SET VALUES FOR THE STATISTICAL PARAMETERS IN THE PROCESSES WITH SPECIFICATION LIMITS – APPLICATION IN LOGISTICS

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Abstract: Processes with specification limits (tolerance) are typical in industrial practice, for example in the control of the manufacturing process. Often these tools are be used in all engineering processes, here is shown an application in the control of the logistics process. To ensure the effectiveness of the process and to meet customer expectations it is necessary to ensure strict compliance with the tolerances [1]. Classic control methods base on variables that require monitoring related to the limits set by the natural process tolerance. In this work considerations expressed for estimating values of the dispersion and the permissible central tendency of the variables from the specification limits, the purpose is to obtain acceptable process capability for the specific case [2], [3]. Considerations are be done in the reverse order, dispersion values and the central tendency is not execute dafter he process determines in this case the maximum permissible valuesof dispersion and central tendency referred to tolerance specification are estimated to guarantee the required quality before you start the process, so this method can be considered as a preventive tool quality.
Keywords: Quality Management, Logistics

INTRODUCTION

The current industry companies have a commercial and technological competence, this competence involves harmonizing measurement systems, and update technologies to obtain satisfactory results with modern control systems quality. Besides the benefits that provide safe and reliable measurements and allows for comparisons with other companies. Current trends in quality control are the key element for continuous improvement; it uses a wide range of engineering tools and techniques, ranging fundamental tools to important development in current manufacturing technologies. It is necessary to find and use new sources of quality improvement, which leads to the use of statistical process control and the use of preventive techniques, i.e., focusing on the control of key input variables of the process, which contributes to creating the output of the desired product in an established quality. Statistical control bases on the application of statistical methods for the analysis, monitoring and control of processes.

Logistics and Quality Management

In logistics appear frequently qualitative parameters, which are measured and whose magnitudes are in turn defined by a maximum and a minimum tolerance limit that is set for that variable. We must have the tolerance as wide as possible and as close as necessary. This is being manifested in various processes and products, which is being treated extensively in the literature mainly with regard to manufacturing processes. An application is being shown in this case to control logistical process. The logistics product is actually a service. These services are essentially sending, collecting or receiving from the client covered by a contract:

- ✓ The correct object= What?
- ✓ The correct amount=How much?
- ✓ In the right place=Where?
- ✓ At the right time=When, how often?
- ✓ With appropriate costs=How many expenses?
- ✓ With the right quality=No damage, incur additional services
- ✓ Environmentally=with less environmental involvement

These aspects lead to a nomenclature to describe a product logistics. Here it refers to "What"(object) to the entire physical world from a needle to a heavy equipment opencast mining, as shown in Figure 1[1].

Each of these terms simplest in turns one or more variables to be controlled, which in turn describe the corresponding quality parameter. Each of these specifications can be expressed by a variable for which the corresponding limits are set and the goal of that variable is within specification limits pursued. A common way to control the behavior of these variables is the control charts, as shown in Figure 2 [1].

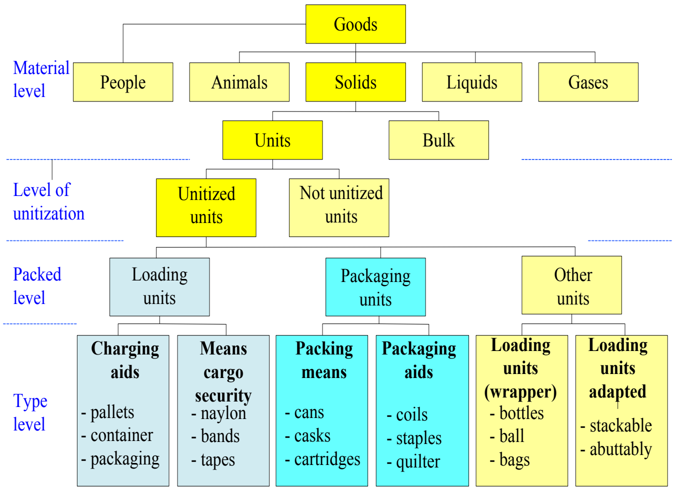

Figure 1: *Goods classification*

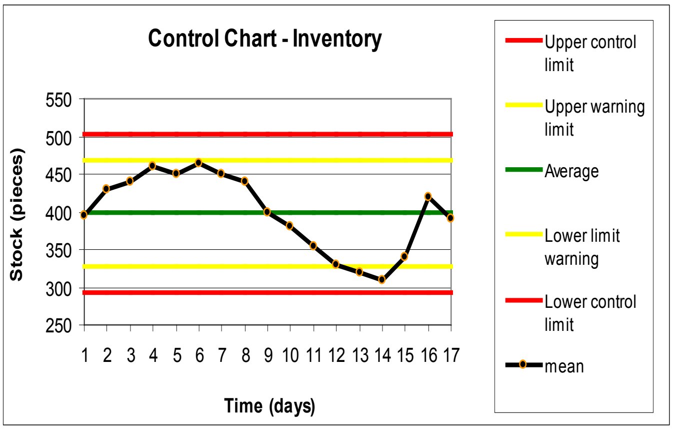

Figure 2: *Chart control limits applied to a logistic process*

Control charts for regulation of central tendency. Control charts for the mean ($\bar{X}$ -Control Charts).

For the statistical control of the central tendency of processes primarily control charts for the mean ($\bar{X}$ - CC) are used in practice. The main objective of the application of control charts for the mean is to immediately and safety determine the existence of systematic distortions in the process expressed in the form of trend.

Practical experiences in the industry, as well as the mathematics of probability, recognize these control charts as the most efficient means to recognizing systematic process changes and interruptions. Conventional data collection and manual mathematical processing require a relatively long time, which minimizes the applicability of these control charts. Now an automated collection and processing of data significantly increases the benefits of this graph, so that the fundamental criterion for the selection of the type of control chart is its effectiveness.

The calculation of the control limits (CL) and warning limits (WL) for a $\bar{X}$ -GC obtains for the case that the standard deviation (σ) is sufficiently known and it is referred to the central tendency (μ) of the process:

$$UCLM_{\bar{x}} = \mu + km_{\bar{x}} \cdot \sigma \quad (1)$$

$$LCLM_{\bar{x}} = \mu - km_{\bar{x}} \cdot \sigma \quad (2)$$

$$UWLM_{\bar{x}} = \mu + km'_{\bar{x}} \cdot \sigma \quad (3)$$

$$LWLM_{\bar{x}} = \mu - km'_{\bar{x}} \cdot \sigma \quad (4)$$

The coefficients $km_{\bar{x}}$ and $km'_{\bar{x}}$ are calculated as:

$$km_{\bar{x}} = u_{(1-\alpha/2)} / \sqrt{n} \quad (5)$$

$$km_{\bar{x}} = 3/\sqrt{n} \qquad \text{for } \alpha = 0{,}27\,\%$$

$$km'_{\bar{x}} = 1{,}96/\sqrt{n} \quad \text{for } \alpha = 5\,\%$$

In case there are predetermined limits or tolerances specification (UL-upper limit, LL-lower limit) calculation of control limits for a process capability indexes $C_p \geq 1$ are performed according:

$$UCLT_{\bar{x}} = LS - kT_{\bar{x}} \cdot \sigma \quad (6)$$

$$LCLT_{\bar{x}} = LI + kT_{\bar{x}} \cdot \sigma \quad (7)$$

The factor $kT_{\bar{x}}$ is calculated as:

$$kT_{\bar{x}} = u_{(1-p/2)} - u_{(1-\alpha/2)} / \sqrt{n} \quad (8)$$

with

$u_{(1-p/2)}$ - Percentile of the distribution of the individual values.

$u_{(1-\alpha/2)}$ - Percentile of the distribution of the mean values.

For the case in which p = 0,27 % and α = 0,27 % obtained:

$$kT_{\bar{x}} = 3\left(1 - 1/\sqrt{n}\right)$$

Control charts for monitoring the standard deviation (s- Control Charts).

The control charts to monitor the dispersion of samples or process (s-GC), are previously seldom used. That is why the mathematical complexity of the calculations is necessary for preparation, this limitation has almost no effect today with the introduction of new computing techniques in manufacturing processes and processes in general, however provides a great advantage from the point of view of its effectiveness to detect changes in the dispersion process. This effectiveness bases on the high information content of the standard deviation and its effectiveness to interpret outliers [1].

The calculation of the control limits (CL) for the control charts for the standard deviation (s-Control Charts) bases on the standard deviation of the process σ in the form:

$$OCL_s = ks_o \cdot \sigma \quad (9)$$

$$LCL_s = ks_u \cdot \sigma \quad (10)$$

Tobe accepted for an error probability $\alpha = 0{,}27\,\%$ obtained:

$$ks_o = c_{2n} + 3\sqrt{1 - c_{2n}^2} \quad (11)$$

$$ks_u = c_{2n} - 3\sqrt{1 - c_{2n}^2} \quad (12)$$

The general procedure for the preparation and implementation of Control Charts for the control variables should be divided in to the following steps:

- ✓ *Determination of the statistical parameters describing the process under control by the process mean (μ) and dispersion process (σ). This determination is made by statistical analysis, in some cases a statistical look ahead is performed or refers to historical data from similar productions.*
- ✓ *For different types of Control Charts for the corresponding statistical parameters (individual values or mean value and*

dispersion for defined volume of the sample) are determined and a proof distribution model is made. There are some exceptions such as non-normal distributions among others; logarithmic distributions and other transformations.

- ✓ *For the process under statistical control are determined μ_o, σ_o and on that basis the boundaries or limits (L) are calculated, into which you can move the corresponding statistical parameters of the sample without the need to intervene in the process.*

Solution for the in determinacy of the sample statically moments

Performing a practical analysis of this problema contradiction occurs in the majority of practical applications. If you have no initial data for the mean and dispersion characterizing the process (μ_o, σ_o) or any estimate there of would be affected by errors, other times the volume of the process does not allow for an initial sample and this forces to establish control of 100% with the known consequences. A possible solution in this case is proposed to proceed as follows:

The fundamental objective is to ensure the quality parameter that expresses the given variable for tolerance (T).

$$T = OL - LL \qquad (13)$$

The centre of the tolerance is expressed by:

$$EC = \frac{OL + LL}{2} \qquad (14)$$

The potential of a process is known to:

$$c_p = \frac{T}{6\sigma} = \frac{OL - LL}{6\sigma} \qquad (15)$$

and:

$$c_{pk} = c_p - \frac{|EC - \mu|}{3\sigma} \qquad (16)$$

Given this relationship it can be inferred that the limit values μ_o, σ_o for parameters (central tendency and dispersion) can be set to fulfill the conditions described by the tolerance specification.

It is to assume that the process have to be sufficiently focused, following the techniques of Taguchi, such that the distance from the central tendency to the upper limit is equal to the distance from the central tendency to the lower limit. Mathematically this condition describes the maximum value of c_{pk} (c_{pk}=c_p) which reaches to the condition expressed in equation 17.

$$\mu = EC = \frac{OL - LL}{2} \qquad (17)$$

The limits for the parameters μ_o, σ_o may be defined so that that the requirements of the tolerance can be fulfilled.

$$\sigma = \frac{T}{6c_p} \qquad (18)$$

By this expression the magnitude of the dispersion refers to the process required potential and its relationship with the tolerance specification.

Using this expression the value of dispersion can be derived from the process capability (necessary process potential) and the correlation to the tolerance of specification. In the case of a process capability of c_p= 1.0, it is neither possible to expound the measurement uncertainty nor the possible displacement of the position, as shown in figure 3. For this general form a minimal value of c_p= 1.33 is required.

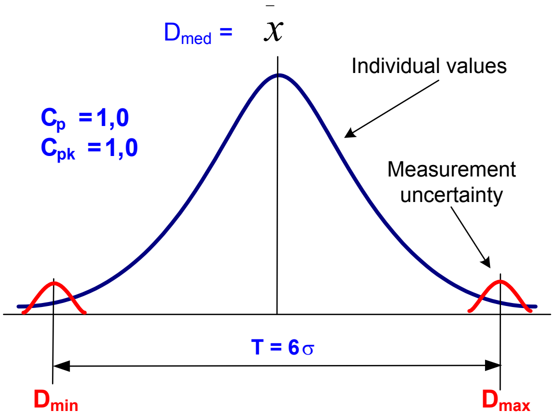

***Figure 3**: Graphical representation of the behavior of the uncertainty in the threshold limit values and considering c_p=1.*

Based on the practical consideration of the characteristic of dispersion and the centering the minimal recommended value of c_p has to be stipulated to 1.33, because this value permits a position displacement. Due to this value there is an equal distance of σ in both directions without increasing the possibility of the variable to exceed the limits of specification.

For the stipulating of adequate values different considerations should exist for every case concerning the economic and technological characteristics.

According to these considerations the measurement uncertainty has to be estimated by using the corresponding, statistical parameters [4]. These displacements exist in every case, even if they can be small. This value can be big for special cases, including the case that the philosophy of 6σ leads to a c_p value of 2.0, as shown in figure 4.

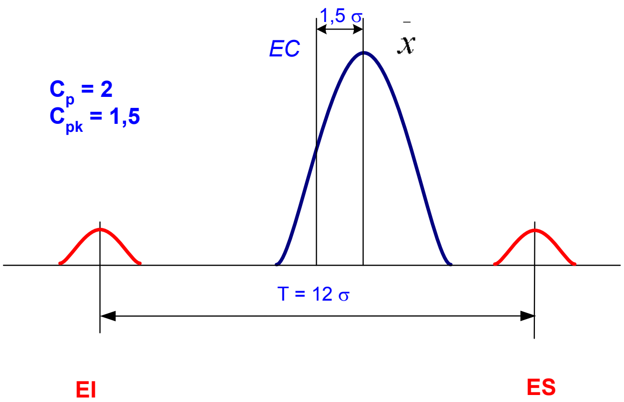

***Figure 4**: Dispersion of process conditions for six sigma (6σ)*

To establish appropriate values for each case other considerations of economic and technological nature [1] should be taken. Alongside these considerations must be assessed the need for the present measurement uncertainty using the corresponding statistical parameters [4]. Also in all cases, even the displacement of the central tendency for these movements to be small is always present. This value may be higher for special cases, even where a philosophy that is valued 6σ, would have a value of c_p= 2.0. This is an example of *employment and improvement of quality tools to prevent potential quality defects and errors, which leads to a conscious action on the rational use of all resources. In general the proposed procedures areas follows figure 5, independence of the values of the average and the dispersion, besides taking into account the capacity of the manufacturing process.*

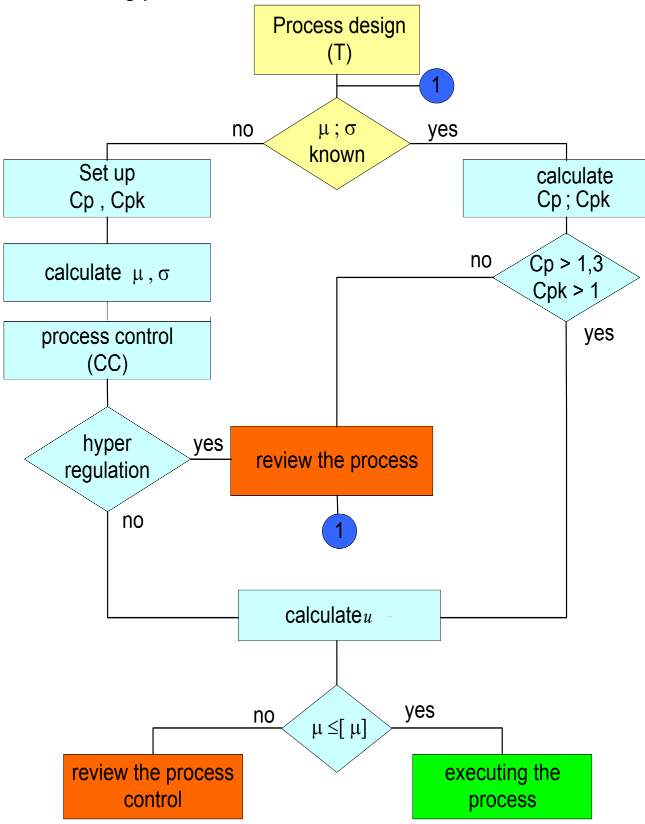

***Figure 5**: Proposed procedures for allocating the actual tolerance*

In consequence of the widespread application of these tools and the awareness of those who must carry it out, it is known that in reference to quality often environmental and sustainability issues are expressed in a close relationship with all aspects relating to quality product. In the development of joint projects in the field of quality management, quality engineering, logistics and the environmental aspect has been sensitizing stake holders on these issues.

CONCLUSIONS

Tools and methods of simple and well-developed assessment can help efficient use of resources for sustainable ecological, economic and social development. The conscious use of preventive quality tools is a potential to be considered in this regard. The possibility of making a prediction oft he values of central tendency and dispersion in the case of control variables allows for a preventive control in the process. Any deviation of the dispersion values and the central tendency established for the process leads to the generation of a signal and thus a required analysis of the causes. That can be supported by using tools of the quality management from a histogram to an experimental design. The solution extends the scope of control charts to those processes in which the valuesof central tendency and dispersion (μ_o, σ_o) are unknown and where it is difficult to carry out a preliminary statistical analysis due to the small volume of production.

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