STATISTICAL TECHNIQUES AND INSTRUMENTS USED IN QUALITY MANAGEMENT

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Abstract: The problem arose once product quality and handicraft production has increased during the industrial revolution. The concept of quality control has evolved over time in the last three decades having been a shift from excessive concerns over the quality / reliability of the product itself, to those related to "generator" of the product, namely manufacturing.In the first half of the twentieth century, those who were turned to product quality techniques and statistical tools for achieving adequate quality. Currently supported seven basic quality techniques (summarized in this article) and seven basic management techniques

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1. INTRODUCTION

A consequence of the transition from craft production to mass production was the loss of control over the quality of the new organization as the final quality depends overwhelmingly on the effects of past work - this situation having production type place where the workshop was the master craftsman tools and steps manufacturing. Complex final product took off the production of a plant does not allow easy highlighting the responsibilities of quality, generically passing this responsibility on the company under whose logo appears product.

2. OBJECTIVES

Until 1924 quality control of industrial products limited to final verification of the products or subassemblies manufactured and withdrawal from the irregular delivery of technical requirements - a procedure known as Quality Technical Control (CTC). But that year, Walter A. Shewhart (1891-1967), an engineer employed at the plant of Western Electric Hawthorne Works Company, presented a memorandum to his superiors only a page containing a simple chart - the chart control - and that laid the foundation statistical control of production and procedure known as Quality Assurance (QA). AC is a set of measures based on statistical theory and practice implemented to formalize procedures of CTC, organizational, training and motivation that a company puts in place to ensure product quality and services. Theory W. A. Shewhart statistical control of production was presented in the book Economic Control of Quality of Manufactured Product which he published it in 1931. Thereafter his interest in statistical control extended to other areas, so that in 1939 was published the second book from the viewpoint of Statistical method quality control, having as editor on WE Deming.

Shewhart's work was taken up and developed by W. Edwards Deming (1900-1993) and Joseph M. Juran (1904-2008).

W. Edwards Deming, during 1939-1945, as an employee of the US Bureau of the Census (United States Census Bureau - an institution that manages both demographic and economic data) and a member of the Technical Committee of Emergency (Emergency Technical Committee - a institution created specifically to the outbreak of world War II) made a number of standards (American war standards) that were aimed at introducing statistical control of production for the war effort.

Joseph Moses Juran, born in Romania, Braila, a Hebrew family who emigrated in 1912 to the United States committed in 1924, the year the WA Shewhart present their theory, the same factory Western Electric Hawthorne Works of concern. Here, he built the team that deals with statistical control of production through the chain advancing to the position of Head of Division. At the end of the war left Western Electric became an economic consultant freelancer.

In 1941 he took over the 80/20 principle - uneven distribution, the economist Vilfredo Federico Damaso and Italian sociologist Pareto (1848-1923) and applied in industry. This principle says that 80% of losses from 20% misconduct, ie losses are never evenly distributed on quality characteristics; always, unevenness of distribution losses is such that a small percentage of quality characteristics (which are vital) have a significant share in the total loss on quality.

Unlike W.E. Deming, J. M. Juran believed that quality control process plays a determining factor and the human component. For Juran, human relations problem was decisive in the production process. He insists to educate and train managers laying the foundation Quality Management (CM). MC is basically a system that ensures quality so as to meet the needs of the beneficiary in terms of product performance, delivery time, price, service, etc. This theory expounded in the book Quality Control Handbook published in 1951. Subsequently he developed Juran Trilogy, a quality management concept based on three components: quality planning, quality control, quality improvement. Juran's vision of quality management industry has crossed the borders being taken and applied in all fields.

At the end of World War II, the American economy, theories of WE Deming and

J. M. Juran were marginalized. In contrast, in Japan, faced with the problem of conversion into a war economy to peace economy works two American authors have produced impression among Japanese economists. Japanese Union of Scientists and Engineers (Japanese Union of Scientists and Engineers - JUSE) invited the two to work in Japan. W. E. Deming invitation in 1950 and J. M. Juran in 1954. Although in Japan the two worked independently of each other, they had a prime role in educating Japanese industrial product quality, and have contributed to the affirmation of Japanese school quality management influencing some of its personalities Kaoru Ishikawa and (1915-1989). It originally stated (1962) concept of Quality Circles (Quality Circles - small group of people who deliberately carries quality management activities in their job, making this task continuously as part of a management program quality covering the whole enterprise) and then to contribute to the implementation of a new system of quality assurance system called Total Quality Management (Total quality Management - TQM).

This system assumes that encompasses the whole community activities organized at the enterprise level employees - managers and workers - in an effort to improve performance fully integrated at all levels. This improved performance is directed towards the final objectives are: quality, cost, lead time, workforce development, design new products. It is assumed that these activities will ultimately lead to ensuring consumer satisfaction.

In the early 1970s have seen the effects of this new management system quality Japanese products become competitive on the world market because of quality and low costs and also caused astonishment and concern in Western Europe and the United States. Thus, TQM has been adopted in these countries.

3. METHODOLOGY

Initially, the techniques and tools of quality management were used statistical methods to control the quality, grouped according to the difficulty of applying them. Of these, seven elementary statistical techniques should be considered basic techniques of quality: the check (control), histograms, correlation diagram, stratification analysis, Pareto chart, cause and effect diagram, control diagram.

Subsequently, a number of other 30 planning and management techniques were chosen seven techniques and tools: affinity diagram, diagram of relationships, matrix diagram, tree diagram, prioritization matrix, analysis diagram of decisions and activities factor.

Currently, the complexity of the quality, appearance of the total quality concept, most of the problems and possible solutions to overcome them, led to the development of new techniques and tools, such as operational research, techniques and tools to improve quality, etc.

All these techniques and tools are called the techniques and tools for numerical data.

Answered in most of the statistics, they are used for:

- Ordering and synthesizing data on quality - sheets, tables, graphics;
- Making decisions on the quality of consignments, based on the sample taken - the techniques of statistical quality control sample;
- Proper functioning of a control process in order to ensure its ability to achieve consistently the required quality - control chart.

Also in quality analysis using other techniques and tools such as process diagram,

Brainstorming, Benchmarking, etc. compatibility matrix, called generic tools and techniques for nonnumeric data.

They are used in comparative analysis to highlight trends, relationships between elements analyzed domain, which is very useful in making decisions.

They allow the ordering and presentation of a set of data quality in a synthetic manner, easily perceived.

4. ANALYSES

The seven basic techniques of quality are :

i) data recording sheets

It is used for the systematic recording of data on quality. The first checklist statistically (sheet for percentage of failure in a batch) was invented in 1924 by Shewhart. We present an example of a sheet to record the frequency of defects:

Table 1. Data recording frequency of defects

Types of defects	Data				Total defects by type
	1	2	...	30	
Type A					
Type B					
Type C					
Total defects					
Who collected the data					
The place where data were collected:					
How have collected data					

ii) Histograms

The histogram or frequency distribution diagram is a graph showing the distribution of a data set as variations (or ranges) grouping feature. It builds on data collected in a frequency table, which divides the total variation in the characteristic intervals, to compare the frequency obtained for each interval, in which case we have the frequency histogram. We can have cumulative frequency histogram and the cumulative variation for each interval of the previous ranges and frequencies.

iii) correlation diagram

Correlation chart or scatter diagram (Scatter Plot) is used to highlight the relationship between two sets of data, one of these categories (x) is represented on the abscissa, and the other (y) on the ordinate.

The correlation between data may be positive: strong or weak, or negative correlation: weak or strong. If the coordinate points (x, y) are highly scattering between the two sets of data there is no correlation.

iv) Analysis by layering

The method of grouping related data, the data points or common characteristics is

called stratification. Stratification and comparison of data is an effective way to isolate a problem.

The following table shows examples of types of coatings used in the workplace:

Table 2. Examples of coatings used in industry

1. For material	Manufacturer, purchaser, brand, place of production, date of purchase, consignment reception, place of production, composition, purity, size, weight, storage time, storage space, etc
2. For machine, device or tool	Type of car, number, pattern, yield and wear, factory, line, tool, size, device, etc
3. For operator	Person, team, age, experience, reliability, etc.
4. For operating procedures and operational conditions	Temperature, pressure, speed, speed, lighting, humidity, operating procedure.
5. For measurements and checks	Tool measuring procedure, instead of measuring the person measuring instruments verification, the verification procedure, instead of checking inspector, etc
6. For time	Time, morning, evening, night, day, week, month, date, etc., immediately before commencing immediately after the operation is completed
7. For medium and condition time	Air temperature, humidity, sunny, cloudy, rainy, windy, snowy, noise, lighting, etc
8. Others	New product compared to the old, good product against defective product, the method of packing, shipping method, etc.,

Stratification can apply on line charts, histograms, correlation diagrams, etc.

v) Pareto diagram

Pareto Chart allows highlighting the most important elements of a problem, to which must be a priority.

A Pareto chart is a diagram of a second vertical axis contains both columns (bars) and lines. On the horizontal axis (OX) are the categories of interest (often "defects") and their frequencies on the vertical axis. OY1 axis (the left) reveals absolute frequency of each category. OY2 axis (the right) highlights the cumulative percentage frequency categories. The columns are arranged in descending horizontal axis (as I sorted and categories). It is recommended but not required to remove the spaces between columns. It is also recommended to have more than seven columns. Cumulative frequencies resulting curve on the graph is a concave curve because the categories are arranged in descending order of absolute frequencies.

Pareto Chart is used for:

- a cross analysis on the principal aspect of this problem;
- deciding goal of improving and to select specific items or causes that produce a more effective improvement;
- predict the effectiveness of various proposed improvements;
- make ordering causes a problem in categories such as material causes, methods, machinery and equipment, the operator;

- establish efficiency improvements.

The figure is an example of application of the Pareto chart defect analysis: the abscissa mentioned types of defects (A, B, C, D), in descending order of frequency.

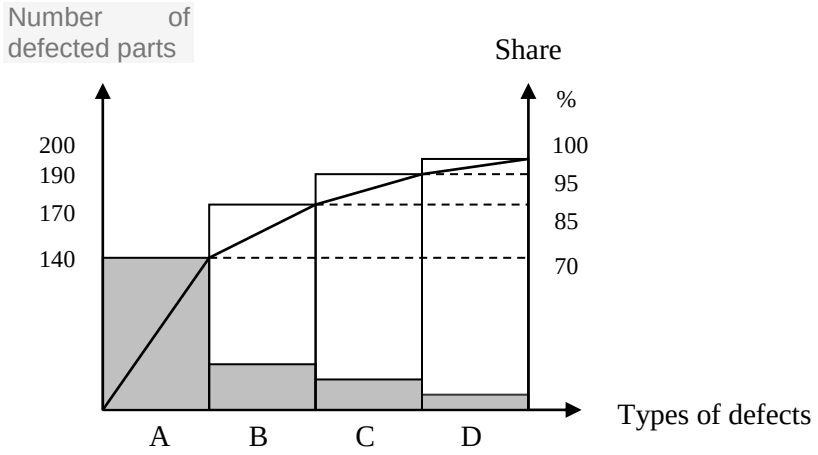

Fig.1. Fault analysis using Pareto diagram

vi) Diagram cause - effect (Ishikawa diagram)

Proposed in 1960, this tool allows highlighting and prioritizing causes a given effect. The effect may be, for example, a characteristic failure of the product the loss of sales, etc. The causes are factors that make the problem exists. They are sorted into categories and subcategories, arranged in graphical form a herringbone (hence diagram is also known as the bone-to-fish diagram, Fishbone diagram).

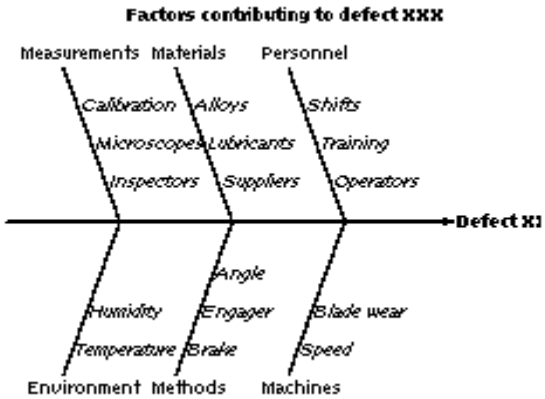

Fig. 2. Diagram Ishikawa

The diagram is also used to investigate the expected outcomes of an action, highlighting the relationships between causes of a particular phenomenon, as registration process ideas.

Steps to follow in building the chart are:

- defining the problem - preferably be done in groups;
- defining the main categories of possible causes (manpower, methods,

environment, machines, materials, etc.);
- identifying all possible causes - using, for example, the Brainstorming method;
- construction diagram;
- development chart.

vii) control chart

Shewhart control chart or diagram can be used for the following purposes:

1. stability assessment process;
2. determining when to be adjusted;
3. improve its confirmation.

Control charts are applicable to all continuous processes with repetitive.

Control chart is like a waveforms: a polygonal line indicates the dynamics of the process studied around a central lines corresponding average feature. If the polyline is maintained between the limits of variation is stable under control.

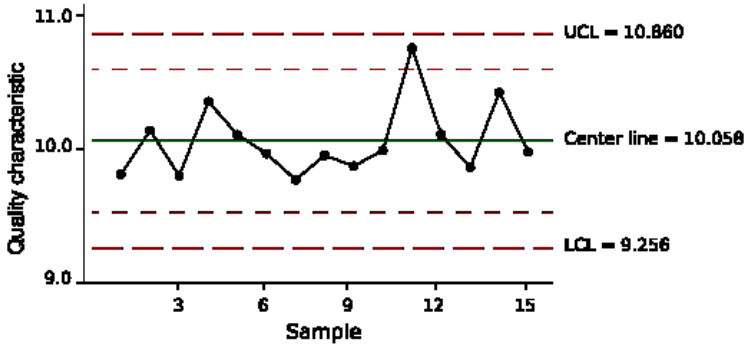

Fig. 3. An example of a control chart

5. CONCLUSIONS

Among the techniques and tools used in nonnumeric data quality analysis present the following two:

i) Brainstorming

It is one of the most used techniques of creativity. Its aim is to get as many ideas about a given topic, with a minimum of restriction group members who apply it. The idea of the method is that more people will generate more ideas than one, no matter how expert is it in the topic covered. Brainstorming will apply at a meeting at which all persons involved should attend. The meeting must be driven by a moderator. Participants must be encouraged to generate as many ideas, no matter how "crazy" they may be. Criticizing the ideas of others is strictly prohibited.

The ideas developed will be grouped into categories. Doubled ideas will be removed; also removed and ideas unrelated to the issue discussed.

ii) Benchmarking

It is used to compare the performance of processes and products and services to those leaders recognized as such at some point in the market. With this method facilitates

the identification and prioritization aims at developing plans to increase competitive advantage in the market.

The steps for applying this technique are:

- establishment of processes and products or services will be analyzed, taking into account their most important characteristics;
- establishment of companies that will do the comparison;
- collection of data on process performance and product analyzed on customer needs;
- ordering and analysis of data;
- identify opportunities to improve the quality, taking into account the needs of customers and the performance of firms that initiated the comparison.

From conception 1920s, when only apply technical control mainly based on technical focus in 1940 has passed quality assurance, based on technical and economic components, by formalizing procedures, and in 1960 to understand the great importance of personality in the context of a business, social axis becomes as important as the other two, thus taking birth quality management. Although classed as Shewhart, Deming and Juran have attracted attention since six decades ago that the so-called process control is the cornerstone of obtaining an adequate quality, process orientation was adopted on a broad scale as managerial policy only in the 90s, which became total quality management. There was therefore a fundamental evolution toward participatory management. A key point to remember: there can be no total quality management and quality assurance it without any technical supervision. And all this is based on statistical techniques and tools either basic or advanced.

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