USE OF STATISTICAL TECHNIQUES IN QUALITY MANAGEMENT SYSTEMS

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This article contains research results, what was made with a purpose to analyse statistical technique using in quality management practices. 34 enterprises and organizations have been analyzed. And a lot of problems in statistical technique using were identified.

Keywords: *statistical techniques, quality management*

1. Introduction

The use of statistical techniques in the practice of quality management of real and modern enterprises is considered in this work. The experience of realization of more than thirty projects of quality management system working out and introduction in enterprises and organizations of different profiles in Latvia and Russia during ten years is analyzed. These projects are based on regulations of the international standard ISO 9001:2000 «Quality management systems. Requirements». The minimum necessary list of procedures for quality management of product and processes is determined in this standard. Formally according to the mentioned standard, statistical techniques (ST) are provided in the structure of these procedures. However, in reality these techniques are not used even in those enterprises whose systems of quality management have been successfully certificated. One of the reasons of such situation is insufficient adaptation of ST to conditions of real processes in production quality managing in modern enterprises, which do not employ specialists with knowledge in mathematical statistics.

A variant of statistical data classification is shown in this work, which is formed in structure of the standard quality management system, and also a variant of description of the cycle of the quality management processes, in the structure of those ST are applicable. The approach of the solution of a problem in the ST introduction at enterprises is formulated. The adapted ST, taking into account the level of personnel readiness, is offered to use. A variant of the complex use of the ST, which is fitted into standard procedures of the organization quality management system, is offered either.

2. Definition of Research Task

This research is based on observations, which ware made in 34 projects of quality management system development and adoption in different organizations and entertainments. In Tab. 1 and on the diagram (Fig. 1) there it is shown, how these organizations and entertainments are distributed among branches of industry.

Table 1

Branches of industry, where the projects were realized	Number of organizations and entertainments
1. Building	6
2. Insurance	5
3. Transport and logistics	3
4. Manufacturing and service	10
5. Trade	4
6. Education, design etc.	6

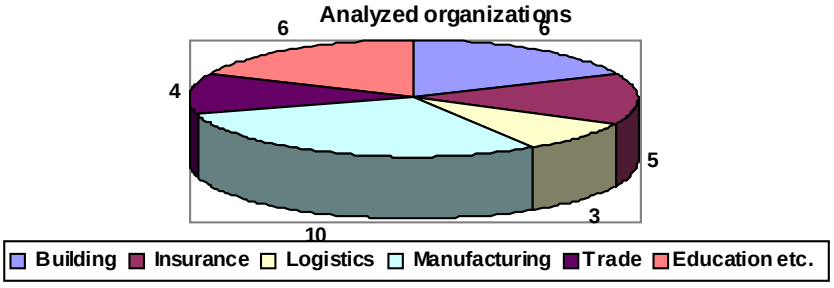

Figure 1

The task of research was to analyse the practical use of ST in these organizations and entertainments. Aren't these statistical data useful for analysis? Whether they need our help for adoption of ST?

It is a number of typical technological and management tasks, where ST may be useful. Among them there are the following:

- grouping of data about product quality and effectiveness of processes,
- detecting of technical object parameter steady departure from norm,
- detecting of the main factor in a number of influencing parameters,
- indicating of dependence between characteristics,
- indicating of difference between characteristics.

There is a number of tasks in a quality management system, which can be realized with the aid of ST, as follows:

- collection of data about product quality level (p.p. 7.4.3, 8.2.3, 8.2.4, standard ISO 9001:2000),
- identification of nonconformities and problems according to quality and process effectiveness (p.p. 7.4.1, 8.3, standard ISO 9001:2000),
- ranging of problems according to their priority (p.p. 8.5.2, 8.5.3, standard ISO 9001:2000),
- working out of corrective and preventive actions, analyzing their effectiveness (p.p. 8.5.2, 8.5.3, standard ISO 9001:2000).

So, two areas of ST use in quality management systems may be formatted:

- first one is data registration and preparation;
- and the second – data analysis and working out of actions.

3. Existing ST analysis

Statistical methods have a rich history of elaboration and use, especially according to research in theory of probability. Here a field of these techniques is represented (Fig. 2) [1, 2, 3, 5].

ST use is connected with the following works:

- statistical analysis of manufacturing and quality,
- statistical analysis of technological processes,
- statistical control of technological processes,
- statistical receiving control of products.

Using these methods needs the personnel competence in the field of theory of probability.

There is big amount of entertainments in Latvia and in Russia, where there are no necessary specialists that could apply ST. That is why ST have to be simplified and prepared for being used without special qualification. It is desirable to use in simple ST graphical interpretation of data and no analytical calculations.

There is a number of methods desired in this direction, as example - "7 (*Japanese*) quality tools"[3] (look at Fig. 2):

1) control papers (for checking result and product nonconformity registration),
2) control cards (for technological process parameter registration),
3) defect level control cards,
4) histograms of control result dispersion,
5) Pareto diagram (for problem rating valuing),
6) dispersion diagram for connection analysis,
7) cause and effect diagram (*Ishikawa diagram*) .

Some tasks of quality management can be solved with use of these tools. But a lot of processes in quality management system are not maintained with necessary simple statistical methods. For example, they are extracts of data, detecting of essential change or essential difference, rating of problems etc. But the main difficulty exists in planning ST use in management. Quality management system procedures have to include ST in necessary places and moments of managing processes. Unfortunately the actual ISO 9000 standard modification doesn't include such requirements.

An approach of solving these problems using ST in quality management systems is analyzed in the following part.

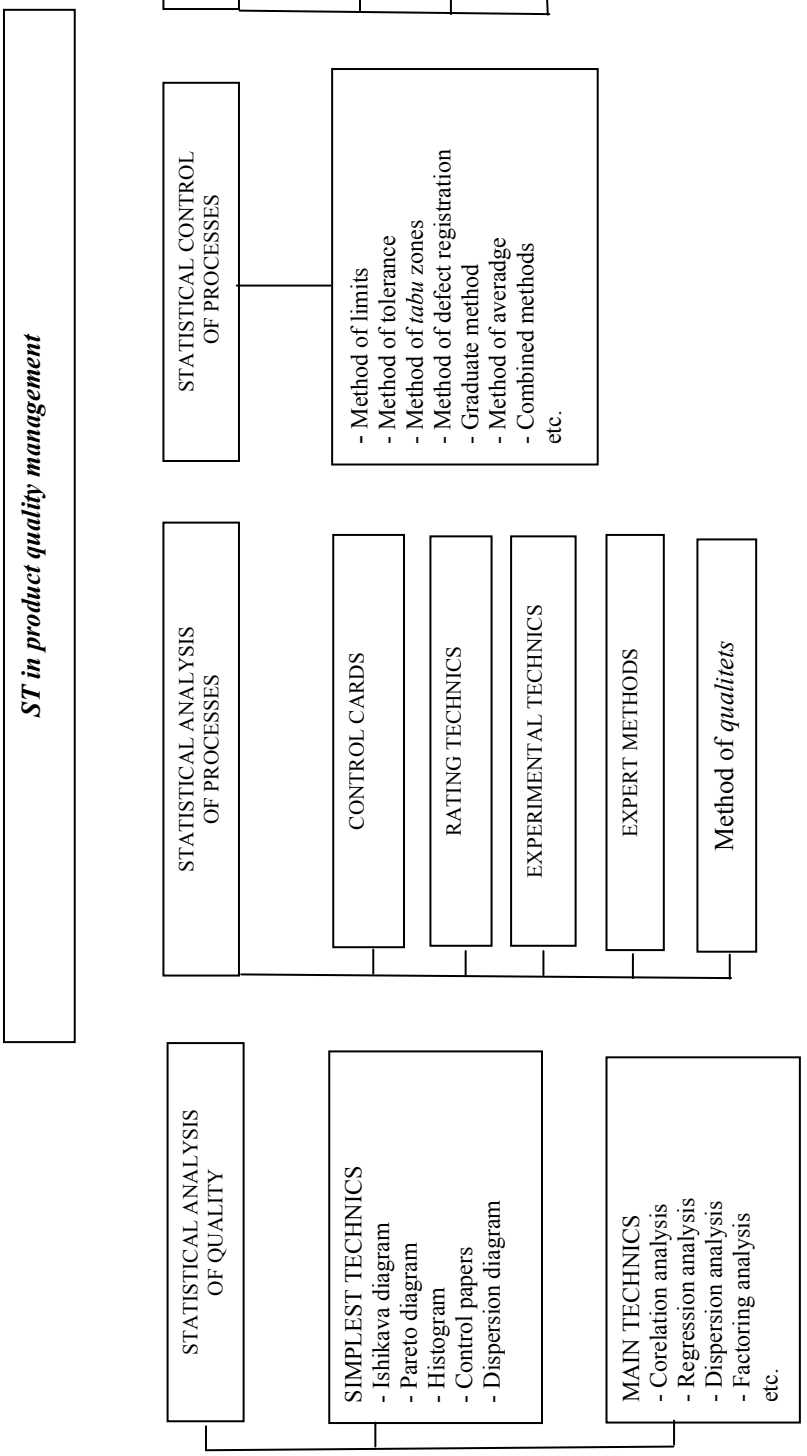
ST in product quality management
STATISTICAL ANALYSIS OF QUALITY
SIMPLEST TECHNICS
- Ishikava diagram
- Pareto diagram
- Histogram
- Control papers
- Dispersion diagram
MAIN TECHNICS
- Corelation analysis
- Regression analysis
- Dispersion analysis
- Factoring analysis
etc.
STATISTICAL ANALYSIS OF PROCESSES
CONTROL CARDS
RATING TECHNICS
EXPERIMENTAL TECHNICS
EXPERT METHODS
Method of qualitets
STATISTICAL CONTROL OF PROCESSES
- Method of limits
- Method of tolerance
- Method of tabu zones
- Method of defect registration
- Graduate method
- Method of averadge
- Combined methods
etc.
STATISTICAL RECEIVING CONTROL
Alternative control
Quantitative control
Quality history

Figure 2

4. Analysis of Statistical Data in a Standard Quality Management System

One of causes of problems with ST using in enterprises and organizations is registered statistical data shortage. One of obstacles in this way is absence of satisfactory registration forms at working places. Do define this problem all the quality records are classified in 5 groups according to quality management task levels with the aid of *the Quality Tower* [1,4]. It is a form of representation of different levels of quality management methodology development. On both of these levels there are different objects of quality control and different data, registered in conformance of ISO 9000 standards (tab. 2).

Table 2

The Quality Tower *(Levels of quality management development)*	**Objects of control**	**Statistical data**
E. Ecology of quality	Ecological, industrial etc. risks	Data about quality costs and losses in accordance with ecology and other risks
D. Quality planning	Objectives of development	Customer satisfaction monitoring results
C. Quality assurance	Management system effectiveness	Quality auditing results. Process effectiveness criteria
B. Quality control	Process and resource conformity	Technological process and resource parameters. Technological process and resource nonconformities
A. Product checking	Conformance of product	Product quality characteristic testing results. Product Product nonconformities

There is a lot of data in a quality management system applicable for using in ST. But very few of organizations really use them for quality level analysis and development.

Observation of 34 enterprises and organizations shows, that only 12% of them use statistical data on a satisfactory level (look Tab. 3 and Fig. 3).

Table 3

Characteristics of statistical data registration in organizations (in accordance Quality Tower levels)	**Number and % of organizations and entertainments**
1. Data are registered at both of *Quality Tower* levels (A, B, C, D, E).	2 (6%)
2. Registered data of product and process quality (levels A, B, C).	2 (6%)
3. Registered data of product quality (levels A, B).	16 (47%)
4. Registered data of product nonconformities (level A).	5 (15%)
5. There is no registration of data related to quality.	9 (26%)

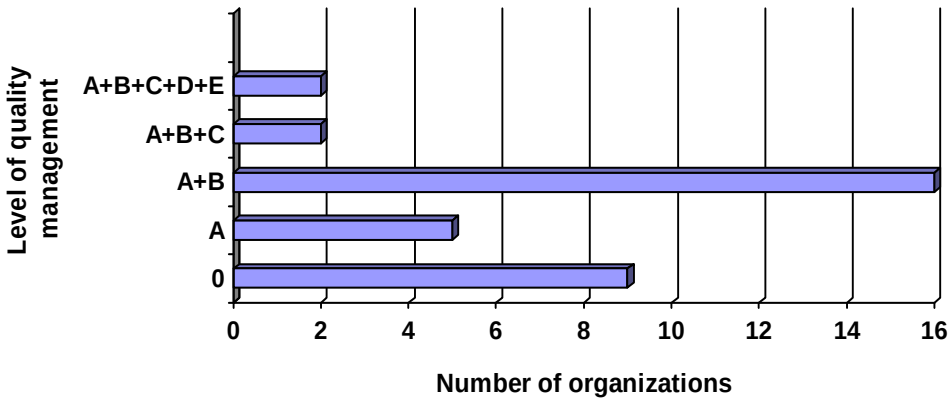

Figure 3

For purposes of management data have to register in a form, which helps to find nonconformities in processes and products and to identify in good time undesirable tendencies. Every organization has to work out acceptable registration forms at all *Quality Tower* levels.

5. Analysis of ST Acceptance in Quality Management Procedures

Here it is worked out the process circle (fig. 4), which includes standard corrective actions (p. 8.5.2, standard ISO 9001:2000).

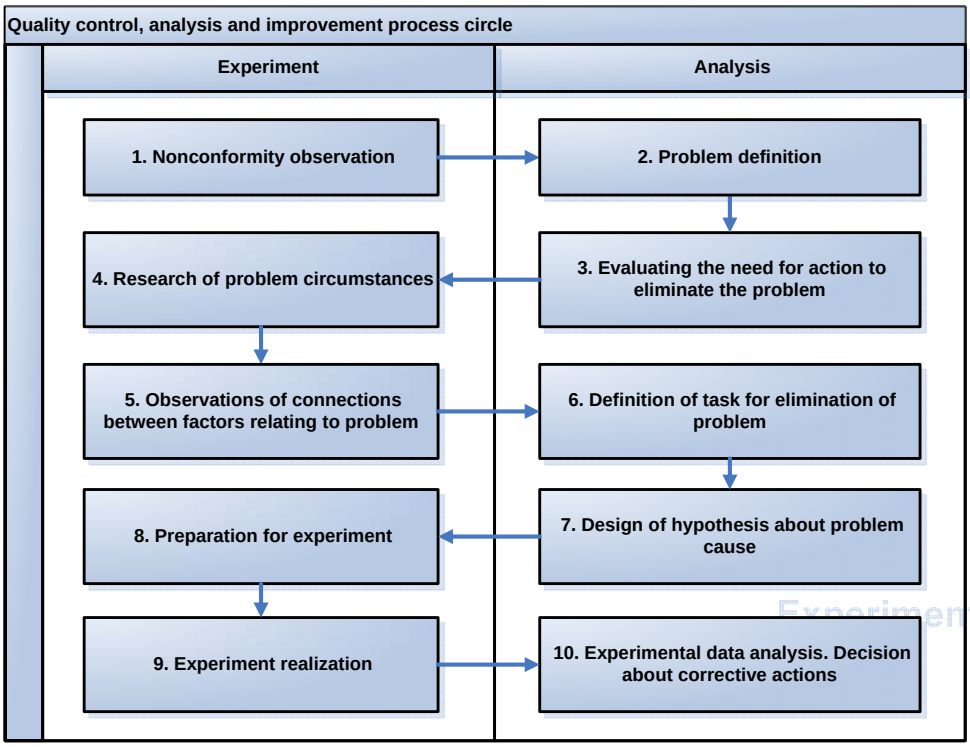

Figure 4

This circle is equal to DMAIC (Define – Measure – Analyse - Improve - Control) circle in ***6 σ*** techniques [5].

This circle has to be defined in a quality management system procedure and has to include ST, as it is showed in tab. 4.

Table 4

№ of step in Quality control circle (Fig. 4)	Actual statistical tasks and ST
1.	Registration of data with the aid of quality papers, quality cards, etc.
2.	To identify the problem it is necessary to define maximal parameter level. It is an actual task – to calculate allowed limits of criteria.
3.	There may be used *Pareto diagram* to range problems and to verify problem importance.
4.	There may be used *Ishikawa diagram* to find connected factors of problem area.
5.	Diagrams of dispersion can detect and verify connections between different factors.
6.	To generalize data of problem organization has to define data forms and rules of data keeping.
7.	There may be used KJ (*Kavakito Jiro*) diagram to work out hypotheses of problem cause.
8.	There have to be assured different circumstances of experiment (such as homogeneity of data, external factor compensation).
9.	There have to be prepared registration forms for experiment results (look p. 1 of this table).
10.	Analyzing of experiment results have to include valuing of their statistical stability in variable circumstances.

Observation of 34 enterprises and organizations shows, that using ST is not satisfactory. The main part of organizations doesn't use ST in their practical management. Generalized results of observation are shown in Tab. 5.

Table 5

Characteristics of ST using in organizations and entertainments	Number and % of organizations and entertainments
1. Systematical use in both management process circle stages	0 (0%)
2. Random use without defined procedures	12 (35%)
3. Organization doesn't use ST in quality management	22 (65%)

Conclusion

A lot of tasks of quality management can be solved with the use of ST. But there is a big amount of entertainments, where there are have no necessary specialists for using ST.

Working out simple statistical data registration forms and graphical ST is necessary for purpose of quality management.

The classification of statistical data and identification of places in quality management processes, where ST are acceptable are represented here. It may be used in research and education planning to join mathematical statistics and quality management.

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