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STUDY OF THE INTEGRATED QUALITY-RISK MANAGEMENT FOR INDUSTRIAL COMPANIES

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***Abstract**: The quality of products is the final expression of the quality of production processes, given the technical, economic, psycho-sensory, etc. performances of the products. Industrial quality refers to the conformity of the product with the normative technical documents (standards, technical data sheets, etc.). Continuous improvement is the gradual improvement of the quality of products and services, productivity and competitiveness, with the participation of all the staff of the company. This way of improving quality has registered a major development in Japan where it is known as Kaizen. Quality risk management is a systematic process of assessing, controlling, communicating, and reviewing risks regarding the quality of products / services throughout their lives.*
This paper briefly describes the factors that influence the quality of industrial products, as well as the indicators for assessing the quality of the products. It insists on the methods and techniques for continuous improvement of quality, especially by appreciating the Kaizen strategy and the stages of designing the integrated quality-risk management system for industrial companies. The last part of the paper presents a model for quality risk management and a predictive risk analysis in quality for planning future corrective actions and necessary measures to prevent their occurrence, as well as concepts and classification criteria for failure analysis and effects.

***Key words:** product quality, industrial quality, productivity, competitiveness, risk management*

1. INTRODUCTION. GENERAL CONSIDERATIONS ON THE QUALITY OF INDUSTRIAL PRODUCTS

The quality of the products is the final expression of the quality of the production processes, given the technical, economic, psycho-sensory, etc. performance of the products. Industrial quality refers to the conformity of the product with the normative technical documents (standards, technical data sheets, etc.). In order for a product to meet the customer's requirements, it must have certain qualities that can be divided into several categories as shown in Figure 1:

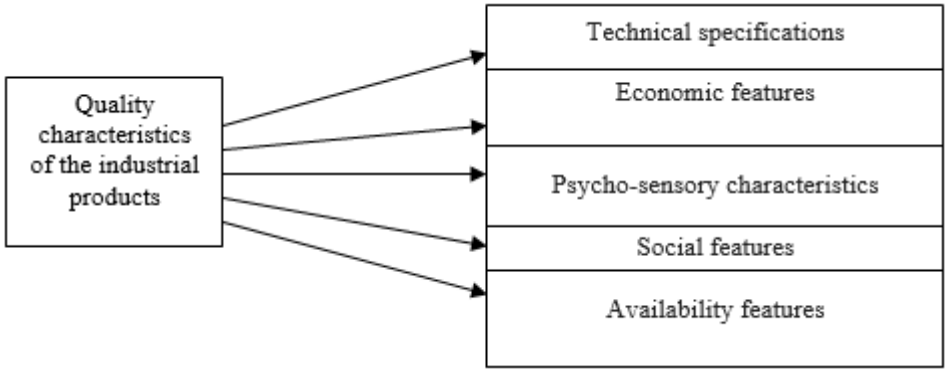

Fig. 1: *Quality characteristics of the industrial products*

1.2. Factors that influence the quality of the industrial products

The quality of the industrial products depends on many factors whose influence is due to the conditions in which the production process takes place. These factors are classified according to the criteria given in Figure 2:

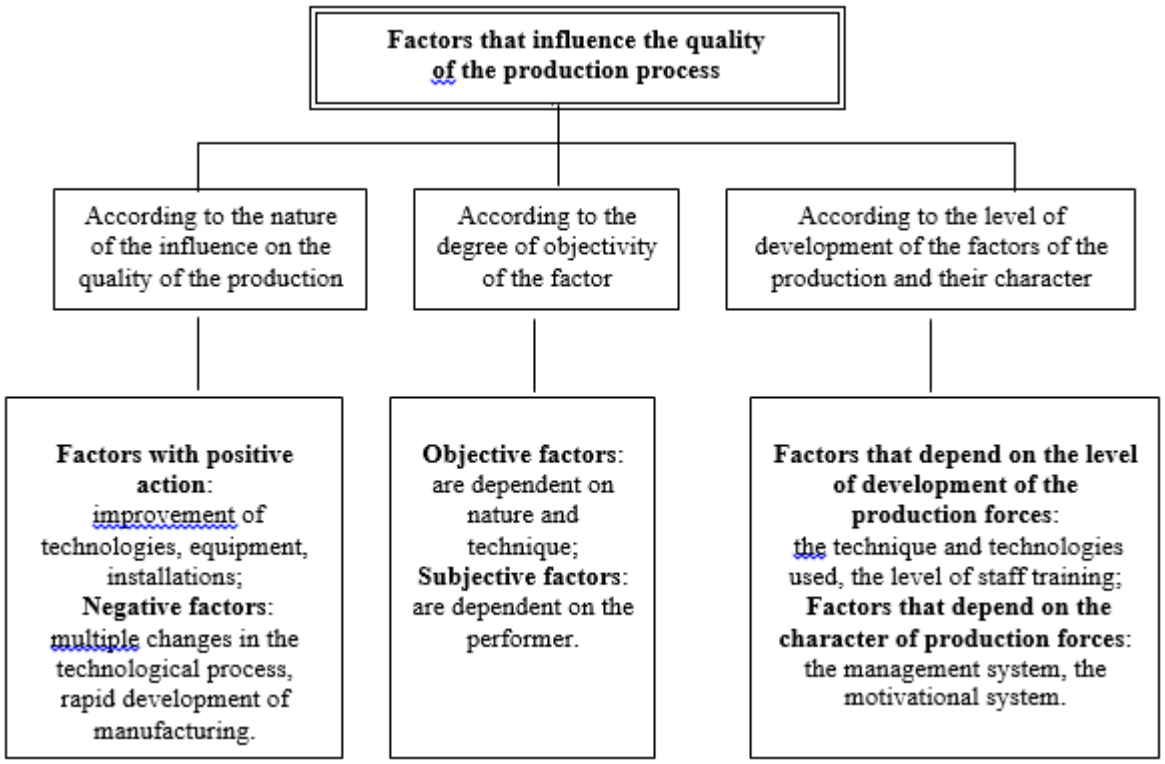

Fig. 2: *Factors that influence the quality of the production process*

2. INDICATORS FOR ASSESSING THE QUALITY OF INDUSTRIAL PRODUCTS

For the quality assessment we can use a system of indicators of which the most important are:
a) partial product quality indicators;
b) quality class indicators;
c) indicators of rejections;
d) indicators of customer complaints.

a) Partial product quality indicators reflect a range of measurable product characteristics, the content of which refers to an attribute, trait or property that meets certain requirements.

b) Class quality indicators are divided into two categories:
1. Indicators that are used by companies making a homogeneous production;
2. Indicators that are used by companies making heterogeneous production.

c) Scrap indicators

The value of rebutted production is determined according to the relationship:

$$R_V = \sum_{i=1}^{n} q_{rdi} x c_{rdi} + \sum_{i=1}^{n} q_{rri} x c_{rri} \quad \textbf{(1)}$$

Where: i – type of product;
q_{rd} – the amount of definitive scrap;
c_{rd} – the unit cost of a definitive rejection;
q_{rr} – the amount of recoverable waste;
c_{rr} -- the unit cost of recovering a recoverable scrap.

Percentage of rebutted production:

The calculation formula is as follows:

$$P_{pr} = \frac{R_v}{\sum_{i=1}^{n} q_i x c_i} x100 \quad \textbf{(2)}$$

Where: R_v – the value of the rebutted production;

$\sum_{i=1}^{n} q_i x c_i$ - the value of production expressed in costs.

The value losses registered by the company in the resumption of production are determined as follows:

$$Pr = Rv - Srec \quad \textbf{(3)}$$

Where: R_v – the value of the rebutted production;

Srec – the amounts recovered by the company by the use of the scrap, the sums withheld from the guilty persons, as well as the indemnities received from the suppliers who delivered the inappropriate materials that generated the appearance of these scrap.

The percentage of losses of the rebutted production is calculated according to the following formula:

$$P_r\% = \frac{\Pr}{\sum_{i=1}^{n} q_i x c_i} x100 \quad \textbf{(4)}$$

Where: Pr - the value losses registered by the company in the resumption of production;

$\sum_{i=1}^{n} q_i x c_i$ - the value of production expressed in costs.

d) Clients' complaints indicators.

These indicators reflect non-quality and refer to:

- The amount of products refused at reception or claimed during the warranty period and their value; - The quantity and value of the products refused or claimed in the total production;
- Expenditure on remediation of the products refused or claimed;
- Number of repair requests per 1000 pieces shipped.

3. CONTINUOUS IMPROVEMENT OF THE QUALITY. METHODS AND TECHNIQUES

Continuous improvement is the gradual improvement of the quality of products and services, productivity and competitiveness, with the participation of all the staff of the company. This way of improving quality has registered a major development in Japan, where it is known as Kaizen. [3]. Kaizen is different from the methods for improving the quality of the European and American managers, which emphasize innovation; the superiority of the Japanese concept results from the fact that for the implementation of the "small steps" strategy, the necessary resources are insignificant, while the innovation-based strategies require very large investments, the change being radical compared to the initial situation. Both strategies are shown in Figures 3 and 4:

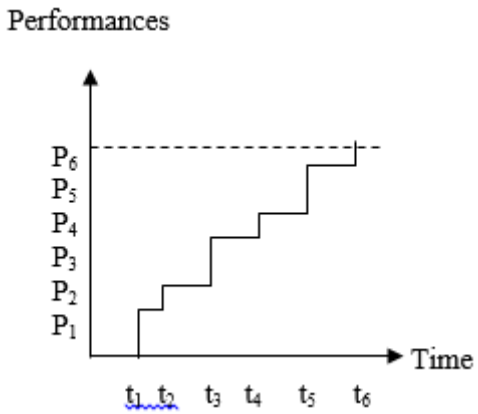

Fig. 3: *Improving quality through Kaizen strategy ("small step" strategy)*

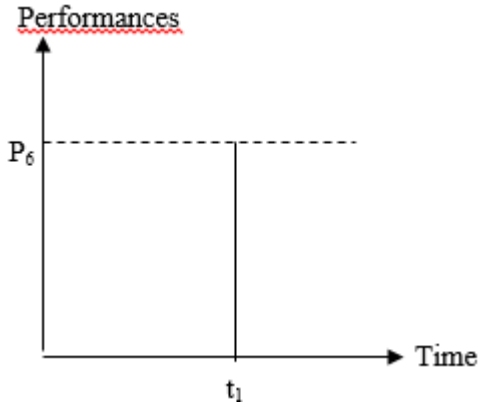

Fig. 4: *Improving quality through innovation ("big step" strategy)*

There are several issues that make a difference between the Kaizen strategy and the quality improvement strategy through innovation, as shown in Table 1:

***Table 1**: The main elements of differentiating the Kaizen strategy from the innovation strategy*

CRITERIA	KAIZEN STRATEGY	INOVATION STRATEGY
Complexity of change	Low	High, radical
Frequency of change	High	Low
Delimitation over time	Continuous	In jumps
Degree of risk	Low	High
Participants	Every employee of the company	Chosen employees for innovating
Motto	Maintenance and improvement	Discarding the previous situation and rebuilding
Technologies used	Conventional know-how and the existing level of the technique	Important technological change, new solutions
Effort	Small investment, strong mobilization	Important investment, low mobilization
The main success factor	Human factor	Technical factor
Effect	Slow economic growth	Rapid economic growth

4. RISK MANAGEMENT IN QUALITY. THE PHASES OF THE QUALITY RISK MANAGEMENT PROCESS.

Quality risk management is a systematic process of assessing, controlling, communicating, and reviewing risks regarding the quality of products / services throughout their lives. A model for quality risk management is presented in Figure 5, but other models may also be used, the emphasis on each component being different from case to case [4], [5].

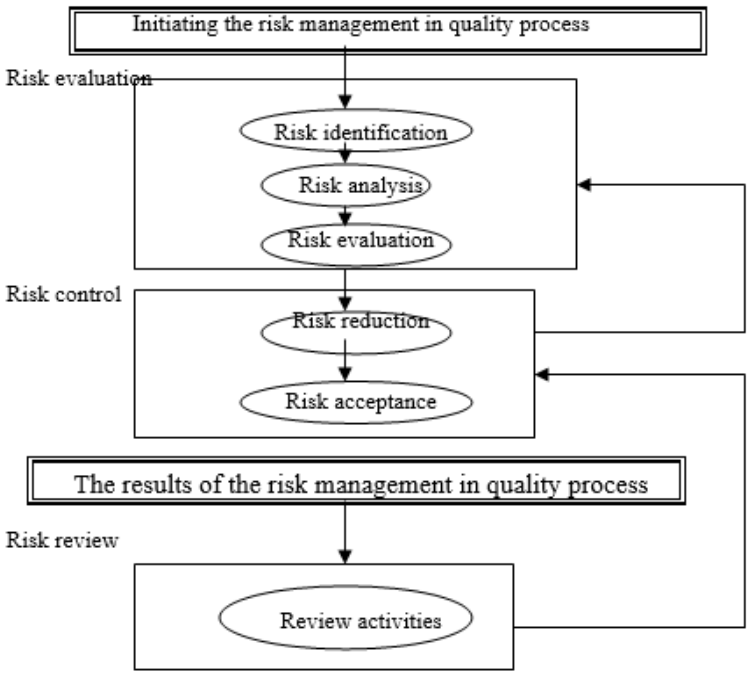

***Fig. 5:** Stages of risk management process in quality*

4.1. Estimative risk analysis in quality

The analysis of failure modes and their effects is a method of analyzing the probability of failure of a product, process or technological system in order to plan the corrective actions and the measures that are necessary to prevent their occurrence [6], [7].

The implementation steps are as follows:

- planning and preparation,
- risk analysis,
- evaluation,
- minimizing risk. [8]

5. CONCLUSIONS

A quality-risk integrated management will simplify the existing management systems within a company by increasing the benefits of each system, will facilitate the optimizing of the resource consumption, and it will also reduce the costs of maintaining more management systems.

It is imperative that in the industrial companies (and not only) the emphasis to be put on the awareness that an integrated quality-risk management will contribute to maximizing the real potential of the organizations, enabling them to integrate as quickly as possible in the business environment.

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