Metrological support management quality assessment

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Abstract. The article presents data on assessing metrological support management quality based on the probabilistic approach. Assessing event probability can be additional important information in planning and analyzing complex processes such as metrological management. The analysis was carried out by comparing the requirements for metrological support with information about real situations. Requirements for metrological support are developed on the basis of regulatory legal acts, company management instructions, optimization of resource consumption, as well as taking into account company development prospects. To a large extent, the achievement of metrological support goals depends on management quality. The final step in assessing the quality of metrological support management is development of the results of assessment and formulation of conclusions (recommendations).

1. Introduction
Modern requirements for the quality of production technologies and high-tech industrial products and services determine a role of metrological support. To a large extent, the achievement of metrological support goals depends on management quality [1-6]. There are a lot of works on metrological support and quality management. But they do not deal with the assessment of metrological support management quality. The “assessment of metrological support management quality” is identification of the degree of metrological support management and shortcomings of the process. Assessment can improve management, its quality and quality of metrological support in general.
This article studies the impact of quality assessment of metrological management in companies.

2. Materials and methods
The method of assessing the mathematical probability of an event and statistical methods for quantifying quality of the company management process were used. The research material is the “metrological potential” of industrial enterprises.
There is an urgent problem of development of the method for assessing quality of metrological support management. This method should be universal, easy to use and take into account requirements of legal acts and specifics of metrological support at a particular enterprise. Management is considered as a complex continuous process performed by the metrological support subsystem.

3. The study of the structure of the modified lead-tin-base bronze
Currently, product quality assurance is based on the use of quality management systems that meet the requirements of international standards ISO 9000 [7, 8]. The most important element of the quality management system (QMS) is its metrological support system, which is an informational and...
analytical basis for managing processes and facilities. It determines the effectiveness of the QMS of an enterprise. Metrological support has a lot of requirements within the quality management systems, including the ubiquitous presence of measurements at the stages of incoming inspection of raw materials, when monitoring and analyzing the accuracy control of technological processes and products, conducting an internal audit and determining adequate control actions [9]. Effective enterprise management should be implemented on the basis of reliable objective information, which can be obtained only on the basis of timely measurements that have required indicators of accuracy and sufficient completeness.

To ensure reliable quality assessment, it is necessary to assess quality of the main interrelated actions that make up the management process:

1. Collection of information on the state of metrological support.
2. Analysis of information. Identification of a problem.
3. Making management decisions.
4. Informing performers about the management decisions.
5. Implementation of management decisions.
6. Monitoring.
7. Analysis of control results and, elimination of deficiencies.
8. Expenditure of time and resources on the management process.
9. Assessment of the degree of goal achievement.

The choice of indicators to assess quality of the above actions is a complex task. Obviously, the indicators should be determined on the basis of company requirements for management and meet the goals and objectives of metrological support.

There are three main options for assessing quality of management of metrological support:

The first option is the simplest and most common. The assessment is based on the opinions of officials. Moreover, these officials can be heads of the enterprise or specially appointed inspectors. The assessment depends on the objectivity of the officials, their experience, competency, knowledge of the situation, requirements and development prospects, ability to draw conclusions and make decisions. That is, the probability of a subjective assessment is high.

The second option is implemented using the method of group expert assessments. It is important to meet basic requirements for experts: a high level of competence in metrological support, independence and objectivity of assessment. That allows for a reliably assessment of the quality.

But within the one enterprise (organization), this is a rather complicated and laborious method that requires a lot of time and a trained working group for its implementation. It should be noted that for a reliable assessment of the quality of management, taking into account all the features of metrological support, it is necessary to develop separate methods for conducting group examinations of the quality of management for each area of activity.

The third option uses statistics. The statistical approach is based on a multitude of quantitative and qualitative indicators of quality assessment. In addition, statistics is used to assess probability of an event, i.e., the probability that the system (process) will meet requirements for the quality level of the functions performed in a given period.

Assessment of the quality of a process by assessing the event probability is of interest and may be additional important information in planning and analyzing such complex processes as metrological management. For example: the probability that the management subsystem will make the best management decision. However, the developed methods for quality assessment through the event probability depend on the reliability of statistical data for the past period do not take into account changes in external conditions; results obtained still require the use of additional indicators and quality assessment methods [10, 11].

It is still rational to use quantitative indicators. Since they are easy to obtain using statistical information; in contrast to qualitative indicators, they are more reliable and less dependent on the influence of various subjective factors.

When using quantitative indicators for evaluation, it is necessary to determine their required
minimum or maximum values and (or) compare them with indicators for the last estimated period (year, quarter, month).

It is also rational to assess the fulfillment of company management requirements (the higher system) and requirements of regulatory legal acts for metrological support based on the principle: “the requirement has met” or “the requirement has not met”.

Quantitative indicators and management requirements must be presented to the inspecting official as a formalized assessment form which can simplify the assessment and reduce time costs.

At the same time, the assessment indicators should express the degree of achievement of the management goal. In turn, the goal of management is to eliminate problems in achieving (ensuring) the required quality of metrological support. Moreover, the problem is the discrepancy between the existing and the required state of metrological support.

The analysis is carried out by comparing the requirements for metrological support with the collected information about the real situation. Requirements for metrological support are formed on the basis of regulatory legal acts, instructions of the enterprise management, resource consumption, development prospects of the enterprise (organization).

Based on the requirements, selected assessment indicators and minimum or maximum values, formalized forms of management quality assessment are compiled. Further, the inspecting official determines real values of the indicators and implementation of the requirements [12].

Assessment of management decisions is based on the objective function [13].

Any decision is aimed at achieving a specific goal. It provides some useful effect associated with costs. Comparison of the beneficial effect with the cost allows us to identify the quality of the decision.

Therefore, the most common indicator is an integral one, the ratio of the beneficial effect (E) to the total cost (C). It is the objective function:

$$ G = \frac{E}{C} \quad (1) $$

The solution maximizing the objective function is the best according to the optimality criterion (2).

$$ G = \frac{E}{C} = \max \quad (2) $$

The synthesis of the optimal solution by the maximum of the objective function (2) suggests two possibilities.

The first one is elucidating the conditions that maximize the beneficial effect at fixed costs. The second one is to minimize costs that provide the same beneficial effect. Thus, criterion (2) splits into two particular criteria, which are satisfied by two different solutions (3) and (4):

$$ G_1 = \frac{E = \max}{C = \text{const}} \quad (3) $$

$$ G_2 = \frac{E = \text{const}}{C = \min} \quad (4) $$

If there is a choice, the optimal solution is one that provides a greater value of the objective function.

A variety of practical problems and approaches to their solution do not allow for further consideration of this issue. In each case, a particular method for the synthesis of an optimal solution is developed according to the criterion of the maximum of the objective function.

Thus, the assessment of the quality of management of metrological support can be carried out on the basis of a comprehensive assessment of the most significant indicators of the quality of management decisions.

The key indicators are as follows:

1) The degree of goal achievement due to the fulfillment of the estimated management decision in
managing metrological support.

2) resources spent on the adoption and implementation of the management decision.

3) time spent on the adoption and implementation of the management decision.

The degree of goal achievement can be expressed quantitatively in the form of a comprehensive indicator that takes into account all important private indicators (5):

$$Q_j = \sum_{l=1}^{n} q_j g_i$$  \hspace{1cm} (5)

where $Q_j$ - comprehensive assessment of the degree of goal achievement; $q_j$ - the private indicator for assessment; $g_j$ - the normalized weight coefficient of this indicator.

The quantitative value of the normalized weight coefficient ($g_j$) can be determined by

1) setting priorities for the tasks performed by the system required to achieve the desired goal;

2) based on the views of competent officials (experts).

In the first case, it can be determined on the basis of statistical data on the functions of the system using which you can draw conclusions about tasks which are most important to achieve the desired goal.

In the second case, you can use formula (6) provided that the competence of officials (experts) is the same, that is, at equal values of the weighting coefficients of officials (experts):

$$g_i = \frac{\sum_{j=1}^{m} r_{ij}}{\sum_{i=1}^{n} R_i}.$$  \hspace{1cm} (6)

In formula (6), the numerator is the sum of scores of the i-th indicator given by all m - officials (experts), and the denominator - the total sum of scores for all n-indicators given by m experts ($r_{ij}$ - score by j-th expert for the i-th indicator).

If it is determined that for any evaluated solution, the goal is achieved, for the subsequent assessment of the quality of these solutions only the resources and time are used [13]

4. Conclusion

The final step in assessing the quality of metrological support management is the development of assessment results and conclusions (recommendations). This information can serve as the basis for making a management decision to eliminate deficiencies and improve quality of metrological management [14 - 16].

It is necessary to consider the metrological support of the enterprise as a set of measures aimed at achieving the required quality of measurements. When developing, manufacturing and operating products, one has to deal with a broad understanding of the content of metrological support, since the quality of measurements is determined by their accuracy and duration; feasibility of certain methods and means of measurement depends on the cost of measurements and complexity of their technical implementation.

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