



Analysis of the Theories for Assessment of the Quality Management Product Efficiency

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Abstract. In the article the advantages of introduction and reasons of low efficiency of the quality management system at the machine-building enterprises are determined. The methods and tools of the quality management system are considered. The conducted analysis of publications has made it possible to distinguish areas in which studies are carried out on the implementation and effective use of the quality management system at machine-building enterprises. A comparative analysis of two versions of ISO 9001 standards has been performed. A functional scheme of product quality management has been developed. The work of domestic and foreign authors on the assessment of the effectiveness of the quality management system is considered. The proposed method will allow controlling the quality of products at all stages of their production. The application of this method makes it possible to assess the functioning of the processes of the machine-building enterprise to determine the most critical ones in terms of quality, as well as can be used to assess both the basic processes of production and the assessment of elements or operations.

Keywords: quality, quality management system, assessment, efficiency, measuring system.

1 Introduction

In the context of the rapid development of the international trade, the quality of products becomes an important tool for increasing competitiveness. The success of domestic machine-building enterprises (ME) in the external and domestic markets depends entirely on how their products meet the requirements of customers and international standards of ISO 9000 series [1].

DSTU ISO 9000:2015 states “a quality-oriented organization promotes a culture that results in behavior, attitudes, activities and processes that add value by meeting the needs and expectations of customers and other relevant stakeholders” [2].

Today, there is no doubt, the quality is impossible to provide only by the control method. One should pay essential attention to quality management (QM). An efficient QM product makes it possible to avoid various failures in the work, to detect and eliminate them in a timely manner with the least losses for the enterprise.

Worldwide practice has shown in order to increase the company's competitiveness, the application of international standards of ISO 9000 series today is a reliable tool for building an effective quality management system (QMS). It provides an opportunity to objectively evaluate the wishes of consumers, turn them into requirements for products, establish production opportunities, find weak-

nesses that impede the achievement of the required quality, choose the correct corrective and preventive actions, assess the level of customers satisfaction and other participants in the production, and outline ways its development.

According to the results of the annual survey of the International Organization for Standardization [3] among the 191 countries which received ISO 9001:2008 certificates by 2017, Ukraine ranks the 60th place (601 certificates) and ISO 9001:2015 – 57th place (702 certificates). Among the CIS countries, Ukraine ranks the third place yielding only to Belarus and Russia.

Domestic enterprises are actively implementing QMS, however, as surveys of employees show, about 60–80 % of QMS are ineffective. The reasons for this are the formal approach to their creation (not for the sake of quality, but for the sake of the certificate, confirmation of its existence), the inattention of the enterprise managers to such a system, the low qualification of the enterprises personnel in the field of quality management, the attempts to solve new tasks by trials and errors, by the forces of service quality only and so on [4].

Thus, increasing the efficiency of QM products, and therefore ensuring the competitiveness of MEs in both domestic and foreign markets, can be attributed to the today priorities.

2 Literature Review

Many publications have been devoted to the question of QM products. Significant contribution to the development of the theoretical and methodological recommendations made both overseas and domestic scientists. Among them, one can note the researches of E. Deming, J. Juran, F. Crosby, K. Ishikawa, A. Feigenbaum, G. Taguchi, J. Harrington, V. Shapiro, M. Shapoval, R. Bychkivsky. But despite the significant contribution to the theory of QM, the practical aspects of the formation of an effective QMS, taking into account the specifics of the Ukrainian MEs, still remain insufficiently researched.

The purpose of this paper is to summarize the experience with product quality management, to analyze the existing methods of assessing the effectiveness of the QMS, to identify insufficiently researched issues and to formulate prospects for further work in this direction.

3 Research Methodology

The continuous improvement of the quality and competitiveness of products have caused the rapid development of the systems, methods and tools of the QMS.

An invaluable contribution to the development of QM has been made by American scientists E. Deming and J. Juran. The well-known Deming cycle PDCA, used in quality systems, is the Deming chain reaction, which indicates the linkage of product quality with the company's core performance indicators, the 14 principles of Deming, which underlie the successful work of QM [5, 6].

In the guidelines for small and medium-sized enterprises of the International Organization for Standardization [7] and several other sources [4, 8–10] it was stated seven simple tools for quality control were developed by K. Ishikawa, known as “father of quality control circles”. Japanese experience has shown 95 % of problems in the workshop can be solved by using seven simple means of quality control: process flow charts; check sheets; graphs; Pareto analysis; cause and effect diagrams; scatter diagrams; control charts. They are intended to analyze quantitative data on quality and allow relatively simple, but at the same time scientifically grounded methods to solve 95 % problems of analysis and QM in the various fields.

However, when new products create, not all facts have a numerical nature. There are factors that are subject only to verbal descriptions. Accounting for these factors is about 5 % of quality problems. These problems arise mainly in the management of processes, systems, teams, and when solving them, along with statistical methods, it is necessary to use the results of operational analysis, optimization theory, psychology, etc. Therefore, a powerful and useful set of tools was developed, which made it possible to ease the task of QM when analyzing these factors, which are called seven new quality control tools. They are systematized and generalized by S. Mizuno [7]: affinity diagram; communication diagram; tree diagram; matrix diagram; arrows chart; diagram of the program implementation process; matrix of priorities.

Proven by time, they are increasingly applied to domestic MEs. However, the results of their application do not always coincide with the expectations of managers. Therefore, a lot of attention is paid to the problems of implementation and effective use of QMS at Ukrainian enterprises.

The analysis of publications made it possible to select the directions in which the research is conducted.

For example, Dryzyuk V. and Fedak O. [4] determined the advantages of QMS implementation and analyzed the reasons for their ineffective implementation at domestic enterprises. Problems, ways of overcoming them and the prospects for the implementation of QMS are considered by Dolgaleva O. V., Orlov P. A., and Boychuk N. Ya. [8–10]. Rudenko L. studied the international experience in QM and prospects of its use at Ukrainian enterprises. Dragnova N. I. in her work considered the directions of the development of QMS and analyzed their advantages and disadvantages. Chekmasova I. A. and Marchenko T. B. offer a methodology for the implementation of QMS in the enterprise [11–12].

A considerable experience in the field of QM theory and the concept of building an integrated QMS has been accumulated. The importance of their implementation at the ME is reflected in works by Valyavsky S. M., Momota O. I., Filipova S. V., et al. [13–15].

The results of scientific research in the field of QM from the point of view of the process approach are presented in the works of Podvyshennoy N. V., Kubishin N. S., Klavdienko N. V., et al. consider QMS as an element of innovative enterprise development [16, 17].

Shvets V. Ya., and Ivanova M. I. provide practical guidance on the formation of an effective integrated QMS. They propose the creation of a special structural subdivision at the enterprise, which will ensure the continuing suitability, adequacy and effectiveness of QMS products [18].

During the research, a comparative analysis of two versions of the standards the previous ISO 9001:2008 and the new ISO 9001:2015 was performed. It showed the new version contains a number of significant changes. More attention is paid to the principles of process approach, leadership, employee involvement and risk-oriented thinking. In our opinion, the main objective of the change in the standard is the need to focus on process management, which will provide insight and continuous satisfaction of requirements, achievement of efficient functioning of processes; improving processes based on the evaluation of data and information [2].

The author's vision of the structure of the QMS, which takes into account the whole life cycle of products, the PDCA cycle, principles, meets the requirements of ISO 9001:2015, are presented in Figure 1.

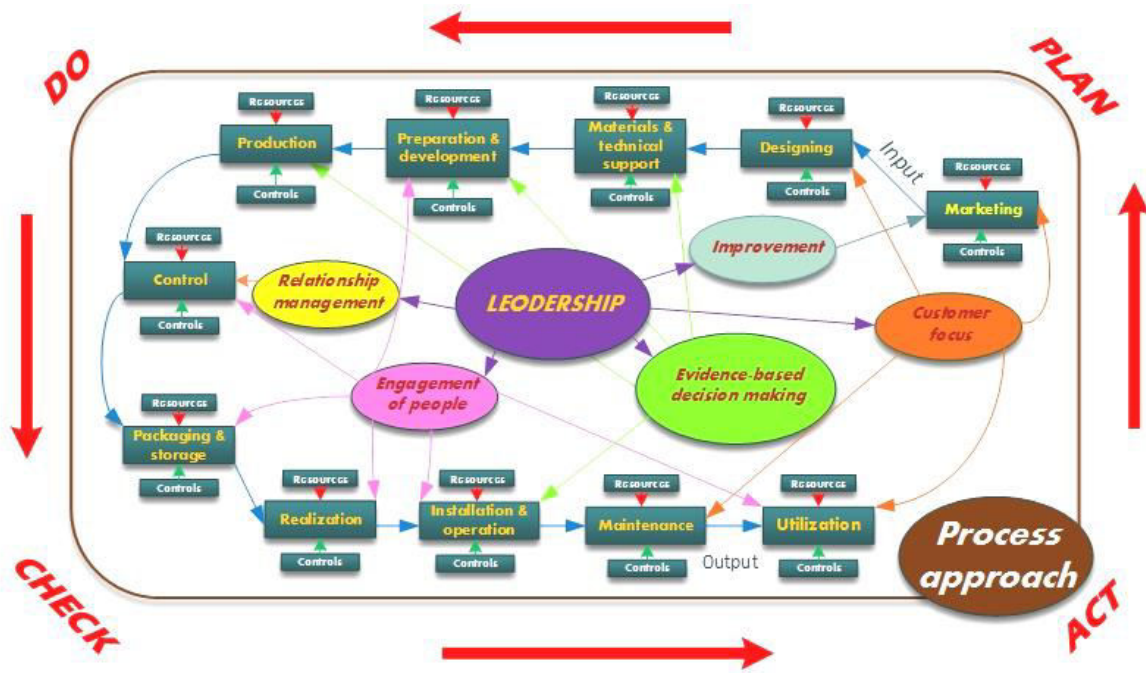


Figure 1 – Functional scheme of product quality management

According to [2, 19], the QMS is based on the seven principles of QM. One of the principles is to improve: successful organizations are constantly improving.

ISO 9001 standards state one of the main tools for improving the organization's performance in the field of quality is the assessment of the effectiveness of the existing QMS. "It is important for the organization to regularly monitor and assess both the implementation of the plan and the effectiveness of the QMS". Another principle of QM involves making decisions based on factual data. Solutions which are based on the analysis and evaluation of data and information likely give the desired results [2, 19].

Thus, the assessment of the effectiveness of the QMS is an important but rather difficult task. On the one hand, there is an obvious need to receive an actual confirmation that the implemented QMS is really functioning and ensures the achievement of the goals of the organization. On the other hand, the effectiveness of processes is constantly affected by a large number of heterogeneous factors, the consideration and accounting of which is a major problem, which critically complicates the task of assessing the effectiveness of the QMS in general and the effectiveness of its individual processes in particular.

However, the standards [1, 2] do not propose a mechanism for a comprehensive assessment of the effectiveness. Therefore, issues related to the problem of adequate and objective evaluations, as well as further analysis of the effectiveness of the QMS, become a problem of both theoretical and practical significance.

The analysis of existing methods for assessing the effectiveness and efficiency of QMS showed there are a large number of methods described in the scientific literature and those applied in practice by domestic and foreign enterprises. For example, the methods of balancing the

system of indicators and self-assessment of key elements of the QMS are widely used according to the recommendations of the standard ISO 9004:2009, the Malcolm Boldridge Grant Rating Scale, the method for determining the perfection based on EFQM criteria, benchmarking (comparative assessment with leading companies), etc.

In works [20, 21] authors have recommended to use the system of Norton and Kaplan balanced indicators to assess the effectiveness of the QMS, which allows at the same time to take into account the interests and the degree of satisfaction of all interested parties.

Gorbenko N. A. based on the of the proposed classification of optimal quality indicators, has developed a unified system of dependencies of the evaluation of the processes of enterprise QMS, which can be carried out in one of twenty variants, depending on the compliance of the individual quality indices with one of the four characteristics of the proposed classification and the importance of the process in the QMS [22].

Gunkalo A. V. proposed to prioritize the QMS processes during its evaluation (based on quality policy and goals) to ensure the development of corrective and preventive actions and their timely implementation, according to the degree of significance, taking into account available costs, by developing a process management model using the system of controlled process indicators [23].

Authors [24] recommend using two types of rating methods for the assessment of QMS. The rating is in absolute form and in a comparative form by changing the parameters of the work of QMS in time or at individual enterprises. Such approaches require an as-

assessment of a significant number of indicators that may change as a result of the implementation or improvement of the QMS.

Chaban O. P. proposed a vector method for assessing the products quality and services that takes into account the broad set of unit quality indices and, through the modules and the quality phase, allows one-to-one numerical integral estimation to be obtained [25].

In work [26] Trish G. N. developed a unified system of dependencies of single quality indicators of heterogeneous processes with a dimensionless scale of evaluation, which allows one to evaluate processes in one of twenty variants, depending on the types of the processes quality indicators and the importance of the process itself in QMS. The algorithm of estimation of dynamic characteristics of processes quality with the use of criteria of non-parametric statistics is developed, which allows to obtain an estimation of the process quality taking into account the time of its functioning.

Zubretskaya N. A. [27] focused on solving the problem of ensuring the reliability of multicriteria assessment and prediction of the quality of industrial products at the stages of design, manufacturing and operation using adaptive methods and intelligent decision support systems. She proposed a conceptual model of the information system of multicriteria assessment, forecasting and quality management of industrial products.

Morteza R. Z. has developed a toolkit to assess the compliance of the standards of management systems based on the use of "expert ranking", followed by "Pareto compromise" by choosing a rational solution that allows to classify the degree of compliance with the standards used to integrate the standards and determine the standard, the main requirements of which accepted as the basis of the integration process.

In [28] N. V. Tereschenko noted that any newly made decision and, accordingly, the change in the number of implemented actions is reflected in the dynamics of the relevant performance indicators. That is why it is proposed to use the rate of indicators' growth assigns of the ordering indicators. In accordance with these requirements, he proposed using the model of index valuation of performance (MINOR) to measure the effectiveness of the QMS and to determine measures to improve it. The offered model allows to reveal critical areas of enterprise activity, which directly influence the quality of production and competitiveness of the enterprise.

Ol'khovskaya O. L., Zaika A. A., and Bal'zan M. V. [29, 30] suggest the use of an automated evaluation of the effectiveness of QMS, based on the method of fuzzy multicriteria analysis, which involves the use of expert evaluation of project indicators, the accounting of pair comparisons instead of quantitative estimates, the consideration of varying importance criteria, which is evaluated by experts.

While Kovalev O. I. in his work [31], for the automatizing evaluation process, he considers the model of the quality of activity and functioning of the enterprise (English activity and functioning, A&F) from the point of view of all possible results, which implies observance of the

efficiency of the logical sequence of "resources – direct results – direct and indirect end results".

K. Szczepanska and M. Urbaniak indicate that the methods for assessing the effectiveness of the QMS improvement should be incorporated into a coherent measurement system and offer tools that allow organizations to assess the effects of improvements in the QMS, such as internal and external audits; risk management, performance indicators and process efficiency, customer satisfaction assessment, qualitative cost analysis; analysis of best practices and self-esteem [31].

R. Ginevicius and V. Petraskevicius on the basis of the proposed classification of the process quality indicators, created a system of interconnections between different sizes of individual quality indices and their values on an immensely large scale, which, in their opinion, allows us to obtain a quantitative assessment of the quality of any process at an enterprise, given its importance in the QMS at a certain point in time and to analyze the situation during this time [33].

There is, therefore, a sufficiently large number of methods for assessing the effectiveness of the QMS, but the vast majority of them are used after the product has been manufactured, which makes it possible to determine the quantity of the defect and not to control it at all stages of the product life cycle. A method is needed to assess the impact of various factors directly on the quality of processes and to obtain objective information about their functioning.

4 Conclusions

Assessment of the effectiveness of QMS products is an important and rather difficult task, as the effectiveness of processes is constantly influenced by a large number of various factors, which complicate the task of assessing the effectiveness and efficiency of QMS. The conducted analysis of publications has made it possible to select the areas in which studies are conducted on the implementation and effective use of the quality management system at the ME and to consider the work of domestic and foreign authors on the evaluation of the effectiveness of the QMS. It is established that for today there is no single method for conducting an assessment of the effectiveness of the QMS, therefore the issue remains relevant and requires further research.

A method is proposed that will allow controlling the quality of products at all stages of its production. The application of this method makes it possible to assess the functioning of the ME processes to determine the most critical in terms of quality and can be used to assess both the basic processes of production and the evaluation of elements and operations.

In our opinion, the practical use of the proposed method allows solving several problems at once: to carry out a quick and effective assessment of all MP processes; to study in detail the structure of processes operating in the enterprise; it is reasonable to choose the process for improvement.

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Аналіз існуючих теорій та концепцій оцінювання ефективності управління якістю продукції

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Анотація. У статті визначені переваги впровадження та причини низької ефективності системи управління якістю на вітчизняних машинобудівних підприємствах. Розглянуті методи та інструменти системи управління якістю. Проведений аналіз публікацій дав змогу виокремити напрямки, в яких ведуться дослідження щодо впровадження та ефективного використання системи управління якістю на машинобудівних підприємствах. Виконано порівняльний аналіз двох версій стандартів ISO 9001. Розроблена функціональна схема управління якістю продукції. Розглянуті роботи вітчизняних і зарубіжних авторів щодо оцінювання ефективності систем управління якістю. Запропоновано метод, який дозволить контролювати якість продукції на всіх етапах її виготовлення. Застосування цього методу дає можливість здійснити оцінку функціонування процесів машинобудівних підприємств для визначення найбільш критичного за рівнем якості та може застосовуватись для оцінювання як основних процесів виробництва, так і елементів та операцій.

Ключові слова: якість, система управління якістю, оцінювання, ефективність, вимірювальна система.