Implementation of the six sigma method in the educational process

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Abstract. The article describes the theoretical and practical aspects of the Six Sigma methodology and features of its implementation to optimize the educational process. The regulatory documents that can be used in the implementation of the method were analyzed. Particular attention was paid to the practical features of the implementation of the Six Sigma method and the development of target indicators of the educational process effectiveness. The developed system of performance targets is reliable and measurable and can be used in assessing the effectiveness of the educational process. The study also provided insights into the benefits of using the Six Sigma method in an educational institution. The goal of the study is to adapt the Six Sigma method for its use in the educational process and to analyze the main difficulties in the implementation of the method. The object of research in this article is the educational process. The analysis of scientific data, systematization was used in the article as a research method. Target performance indicators were developed by compiling and detailing information from literary sources, government standards and regulatory documents.

1. Introduction

The use of modern statistical methods can significantly improve the quality of the educational process, and improving the quality in turn makes it possible to gain competitive advantages both for a particular educational institution and in general for the education system at the state level. [1] To ensure the high quality of education, all processes must be defined, aligned with the goals and constantly improved. [2, 3]

The management of processes in an organization can be carried out by many methods of quality management, lean manufacturing, among which is the Six Sigma method. It should be noted that traditionally the Six Sigma method is used at manufacturing enterprises to reduce defects and costs, as well as for quality management in production. [4, 5, 6, 7, 8, 9] However, the educational process, like any other (including production), needs to be managed, as the controlled state of the process ensures its stability and effectiveness. In contrast to the production process, the object of management in the process of education is not a product, but a service.

It should be noted that studies that specify the implementation and application of the Six Sigma method in educational institutions are few. Most of the studies in this area are general in nature and do not reveal the practical implementation of the Six Sigma method of setting process performance targets and their confidence limits in the educational process.

2. Research methods

This article presents an overview. The following research methods were used: description, data analysis, its systematization and generalization.

As a basis for the study, materials of articles by Russian and foreign scientists were used (Zhabreva V.S., Grigorash O.V., Zolotukhina V.A., V.H. Patil and others) on the application of statistical methods of quality management in general and the method of Six Sigma in particular, as well as
regulatory and legislative documents in this area: international standards for quality management, statistical management and lean manufacturing, federal educational standards.

3. Research results

The implementation and application of the Six Sigma method is based on the standard GOST R ISO 13053-2015 Statistical methods, Quantitative methods for improvement of processes "Six Sigma". However, it should be noted that this standard is aimed at product management and is not adapted for use in the educational process.

After analyzing the provisions of the standard GOST R ISO 13053-2015, it is possible can distinguish the following stages of the implementation of the Six Sigma (Figure 1). This scheme is relevant for any type of organization, including an educational institution.

![Figure 1 Stages of implementation of the Six Sigma method in the educational process](image)

This scheme is similar to the PDCA model, which is set forth in the standard GOST R ISO 9001-2015 and provides for continuous improvement of each process in the organization. Thus, the integration of the Six Sigma method into the quality management system of an educational institution based on the process model is possible.

The main difficulties of implementing the Six Sigma method that an educational institution faces can be classified as follows:

1) Problems of correct application of the methodology and selection of performance indicators. This is a group of problems associated with accurate identification of process targets, their confidence limits, proper measurement and analysis, accurate identification of root causes of a problem affecting the effectiveness of the educational process;

2) Resource provision problems. The provision of the educational institution with qualified personnel (training of employees for the Six Sigma method), material support of work.

3) Organizational and managerial problems.
Staff involvement, competent planning of work on the method implementation, bringing information about the need to implement the Six Sigma method to all participants in the educational process.

If the second and third groups of problems are common to all types of enterprises implementing the Six Sigma, then the first group of problems requires specification, due to the specificity of the goals and objectives of the educational process.

It should be noted that the primary task in adapting the Six Sigma method for analyzing the educational process is the development of target performance indicators, since it is these indicators that significantly affect its quality.

Target process indicator makes it possible to assess the purpose of the educational process. The purpose of the educational process is the transfer to the student of knowledge and skills in accordance with the curriculum for the formation of the necessary competence. [10] If we consider the educational process within the framework of quality management, we can distinguish the following inputs and outputs, resources and requirements (Figure 2).

![Figure 2: Simplified scheme of the educational process in the framework of quality management](image)

Thus, the educational institution on the one hand transforms the student’s knowledge and skills into deeper and more extensive ones, and on the other hand provides the student with new knowledge and skills in accordance with the requirements of the curriculum, methodological recommendations and program. However, the assessment of a student’s knowledge and skills cannot tell the quality level of the educational process in full, since these indicators are quite subjective and depend on the motivation and personal qualities of the consumer of educational process - a student. [11]

After analyzing a number of literary sources [10, 12, 13] and detailing the information given therein, we can single out the following system of quality indicators of the educational process (from...
the point of view of the process consumer) - Figure 3. It should be noted that the system of indicators can be expanded depending on the type of school, the form of education of the student, etc.

Figure 3 Target performance indicators of the educational process

These process indicators can be measured by the results of an internal audit of the quality management system, certification of specialists, inspection audit and do not depend on external conditions (progress and motivation of the student). For example, the indicator “Qualification of a teacher in the field of his/her subject” (Qt) may include such measurable components as the academic degree - AD and the title - AT of the teacher, teaching experience - TE, honored titles - HT, publication activity - PA (number of scientific articles, monographs, textbooks, etc.).

Thus, the proposed system of process goal indicators is objective and can be used as a baseline when adapting the Six Sigma method for the educational process.

Another main task is the quantitative measurement of process targets and the establishment of their permissible limits. The quality of the educational process Y is a function of the input effects of indicators X₁, ..., Xₙ. The magnitude of the deviation of the real value from the target ∆Y is also a function of the variations in ∆X₁, ..., ∆Xᵢ. Reducing the variability of these deviations is the main objective of the Six Sigma method. [14] The indicators of the learning process should fall within established confidence limits, and exceeding them is just as undesirable as going beyond the minimum value. Thus, for example, increasing the number of equipment per student is a signal of inefficient use of resources, which leads to additional process costs. Figure 4 shows an example of the optimal distribution of the indicator “Amount of laboratory equipment and tools per student”. Measurements should be carried out in all specialties. In this example, the boundaries are set from 1.2 to 1.8 pieces of equipment per student (since spare equipment is needed in case of a breakdown).
This distribution is normal and shows that the indicator “Amount of laboratory equipment and tools per student” is in a controlled state (within the confidence limits). The amount of equipment in this case is optimal and does not require correction.

The boundaries of indicators can be set in a particular educational institution based on the requirements of the Federal state educational standards, professional standards for teachers of universities (Order of the Ministry of Labor of Russia No.608n dated 08.09.2015), the curriculum of a particular institution, the requirement of organization standards for a quality management system.

However, it should be noted that not all indicators are established by regulatory documents and legislative acts. Some indicators are set by the educational institution based on the analysis of statistical data, practical experience, analysis of student performance, analysis of the knowledge management system.

The implementation of innovations is always a time-consuming work, which requires special qualities from all participants and the optimal organization of process management. The importance of staff qualifications and involvement in the implementation of the Six Sigma method in the educational process should be noted. Specialists should know both the methodology for conducting the Six Sigma and the methodology for conducting the educational process, as well as, if possible, have practical skills for implementing this method in a particular enterprise. [15, 16]

4. Discussion of the research results

The article highlights the main difficulties in adapting the Six Sigma method to the educational process. The main practical task of the study is to develop targets for the educational process and their permissible boundaries.

As a result of the analysis of the inputs and outputs of the educational process, it is revealed that the input and output of the process are skills and knowledge that are transformed or expanded during the learning process before the student acquires the necessary competence. However, the quality of knowledge and skills of the process consumer - the student - depends not only on the quality of the process itself, but also on the external conditions (student’s personal qualities, motivation, health status). Thus, target indicators should be measurable and objective. These indicators are proposed in the study (Figure 3), but they can be expanded or modified depending on the type of educational institution and the form of education.

The important component for the effective implementation of the Six Sigma method in an educational institution is the availability of qualified and interested professionals. Largely due to the
involvement and literacy of the staff, such a tool of lean manufacturing as the Six Sigma can be implemented not only formally, but also implemented in practice.

However, until now, the Six Sigma method has not found wide application for analyzing the effectiveness of processes in educational institutions. This is due to the lack of regulatory documentation specifically in the provision of services, including educational services. The support of the method at the state level through the development of standards and recommendations for its use in education will contribute to its wider dissemination. The materials of this article can be used in practice in the development of techniques for the implementation of the Six Sigma in specific educational institutions.

5. Conclusion

The Six Sigma method is one of the tools of the lean learning system implemented in an educational institution as an element of a business strategy and is aimed at the improvement of the efficiency of the educational process.

It should be noted that the implementation of the Six Sigma method in an educational institution makes it possible to achieve the following advantages:
- To establish effective use and allocation of resources (material, administrative, personnel);
- To improve the quality of the educational process by reducing the variability of deviations of target indicators;
- To optimize the time of the learning process.

The Six Sigma method allows reducing the variability of educational process target indicators and ensuring its compliance with the requirements of concerned parties: students, teachers and the state.

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