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QUALITARIAN MODELS AND QUALITY CONTROL TOOLS FOR THE PRODUCTION PROCESS IN THE INDUSTRIAL ENTERPRISES

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Abstract
In modern industry, one of the primary goals is to increase the efficiency of production processes and improve product quality. Quantitative models and quality control tools play a significant role in the improvement of industrial processes. This article presents the theoretical foundations of qualitarian models and quality management tools, methods of their use and practical examples.
Keywords: quality control, qualimmetric modeling, metrology, innovative technologies.

Theoretical foundations of qualimmetric models. Quantitative models are an important method of quantitatively evaluating and controlling quality in the production process. For example, Toyota Motor Corporation has significantly improved production efficiency by integrating Lean and Six Sigma methods, in which qualimetric models have been used as the primary tool for quality control. General Electric, on the other hand, was able to reduce quality problems by 35% by optimizing processes using the Six Sigma methodology. Also, Nestlé implemented the ISO 9000 standard, improving product quality by 15%. These practical examples clearly illustrate the effectiveness of using qualimetric models. The theoretical foundations of this approach are elaborated by R. G. Karapetyan and A. V. Frolov and is widely used in mathematical modeling and evaluation of quality. Quality management systems like ISO 9000 standards and GOST 15467-79 serve as the main guides in the application of these models [1-7].

Scientific basis of quality management tools. Quality management uses systems such as Statistical Management Tools (SPC), Total Quality Management (TQM), and Lean/Six Sigma. These systems offer the possibility for monitoring and controlling the quality at all stages of the production process. In particular, the SPC determines the stability of the process through statistical diagrams and helps to identify faults at the early stages. TQM, on the other hand, organizes quality improvement throughout the company and ensures the participation of every employee in quality management. The Lean/Six Sigma methodology aims to improve production efficiency by reducing redundant processes and keeping quality unchanged [8-11].

Each of these approaches is widely used in modern industrial enterprises. For example, in the automotive industry, SPC methods are successfully used to detect faults at early stages. In pharmaceutical enterprises, TQM allows for continuous improvement of quality based on customer requirements. In electronics manufacturing, Lean/Six Sigma helps achieve significant advances by improving process efficiency and reducing waste. The flexibility of these approaches allows them to be successfully applied to different industries. For example, using SPC's Shewhart diagrams and Ishikawa diagrams, it allows you to visually show

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problems in the process and develop strategies for solving them. The main advantage of TQM is that it improves the overall efficiency of the enterprise by increasing employee motivation and focusing on quality issues [9-13]. Lean and Six Sigma, on the other hand, play an important role in ensuring high quality, for example through reducing defects and optimizing processes at every stage of production.

- **Reliability Theory**: Developed by J. M. Juran and P. Crosby, it aims to improve the reliability of products and processes.
- **Statistical Analysis**: Shewhart diagrams and Ishikawa diagrams are two of the most effective tools in quality management.

Integration of qualitative models and quality assurance tools

The combined application of qualitarian models and quality control tools increases production efficiency. As mentioned by M. Hammer and J. Champy, business process reorganization (BPR) and quality management systems play an important role in ensuring quality in the production process.

Practical Examples. A number of examples of using qualimetric models and quality control tools in industrial enterprises are given:

- **Toyota Motor Corporation** improved its quality management system by combining Lean and Six Sigma methods. Through this system, the efficiency of time and resource utilization in production processes is significantly increased. The table below presents Toyota's results in quality management on an annual basis:

Table 1.

Year	Increase in production efficiency (%)	Decrease in defective products (%)
2000	5	20
2005	10	15
2010	18	12
2015	25	8
2020	30	5

According to this information, significant progress has been made in quality issues as a result of the integration of Toyota's Lean and Six Sigma methods. For example, from 2010 to 2020, production efficiency increased from 12% to 30%, indicating that processes are optimized. And the number of Lean/Six Sigma products decreased from 12% to 5% over the same period, which clearly demonstrates the effectiveness of the Lean/Six Sigma approaches. Through the diagram, you can see the following:

1. The production efficiency has increased year on year, as evidenced by the optimised processing of processes.
2. And the number of defective products has been reduced to almost a minimum. These results confirm Toyota's success in quality management.

- **General Electric**: Improved production efficiency using statistical controls. They have achieved process optimization by applying Six Sigma and other statistical controls to manufacturing processes. The table below shows the impact of these processes on productivity:

Table 2.

Year	Increase in production efficiency (%)	Decrease in quality issues (%)
2000	5	18

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2005	12	15
2010	20	10
2015	28	8
2020	35	5

These results are also illustrated by the diagram as follows:

1. **Production Efficiency**: There has been a significant year-on-year increase, which confirms the effectiveness of statistical management tools.
2. **Decrease in quality issues**: Brac indicates a significant reduction in the number of products.

- **Nestle**: By implementing quality management system based on ISO 9000 standards, it has increased production efficiency by 15% and reduced quality defects by 20%. The table below shows the changes over the years:

Table 3.

year	Increase in productivity (%)	Reduction of quality deficiencies (%)
2005	2	25
2010	5	22
2015	10	18
2020	12	15
2022	15	20

Also, the following diagram devotes the dynamics of these indicators:

1. The increase in productivity has been increasing year on year.
2. Quality defects are significantly reduced.

Conclusion

The introduction of qualimetric models and quality management tools in the industrial enterprises contributes not only to the improvement of product quality. At the same time, this process improves the overall efficiency of production. Such systems ensure the efficient operation of the enterprises by reducing breakdowns in production, optimizing the process, and reducing costs. In the future, thanks to the widespread introduction of automation and digitalization technologies, there are opportunities for further improvement of qualimetric models and real-time monitoring of each stage of production. This approach contributes greatly to increasing the competitiveness of the industrial enterprises, as well as to the production of high-quality products. However, there are also several difficulties in implementing these models. For example, incomplete or inaccurate initial data may adversely affect the accuracy of results. In addition, the effective application of such models requires highly qualified specialists and modern technologies, which can increase costs.

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