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Article

Product Quality Planning in Laser Metal Processing Based on Open Innovation Using Quality Function Deployment

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Abstract: The results of the development of a modified quality function deployment (QFD) method, obtained for the first time to improve the product quality planning process in the metal cutting of laser technologies confirming the dynamics of open innovation, are presented. When using new marketing technologies, the requirements of consumers are established; a factorial model of customer satisfaction was determined with after an assessment by expert methods, their wishes were transformed into indicators of product quality, and its concept was developed. Product quality is enhanced by optimizing project specifications. The method of functional cost analysis (FCA) was applied for the manufacturing processes, which made it possible to reduce the costs of their implementation. New methods of product quality control were applied. The developed planning process is described by a sequence diagram, an algorithm, and a responsibility matrix. The research used search methods including Internet resources required for open innovation, namely functional modeling methods (IDEF) and the method of advanced product quality planning (APQP). The results of the achieved advantages of open innovation (reduction in research and development costs, implementation of the principles of total quality management (TQM), customer orientation, process approach, improvement) are recommended for further application both at the enterprise and in the metalworking of mechanical engineering. The practical significance of the results of this work is the reduction in internal and external failures by 12%; reduction in time for new product development by 9%; reduction in costs for online resources by 11% and quality control during production by 7%; reduction in labor costs for process management by 25%; and the stability of the process, which improved by 25%.

Keywords: quality function deployment (QFD); open innovation; house of quality; functional cost analysis (FCA); functional modeling methods (IDEF); consumer requirements; total quality management (TQM); advanced product quality planning (APQP)

1. Introduction

" ... it is not products, but the processes of creating them which bring companies long-term success."

M. Hammer, J. Champy

The Ural region has long been considered the "forge of Russia", and the cornerstones of manufacturing in the Urals are metallurgy and the defense industry. However, the industries require development and the introduction of new technologies. Currently, the defense industry of the region is directing significant funds towards increasing the volume of manufacturing and the modernization and refitting of production facilities. With this approach, it has been concluded that an enterprise such as Laser Technologies JV OOO turned out to be a valuable business for the region. In addition, the value of metals and metal goods in business and daily life cannot be overestimated. Man has come a long way from using natural copper to the complex alloys of the 21st century, which is largely due to the rapid progress of science and technology. However, modernity requires new approaches for the metal processing industries. This is due to the rapid development of so-called "high technology" [1] that requires high-precision methods of manufacturing [2]. The idea of using laser technologies for industrial metal processing is not new, and these technologies have been used for around 20 years. For example, laser methods and technologies are widely applied in the cutting, thermal processing, welding, alloying, and cladding of various metals. However, metal cutting is the main operation that has been completed with the help of laser technologies [3]. The work of Laser Technologies JV OOO (a limited liability company under the laws of the Russian Federation) involves the laser treatment of rolled metal and pipes, metal bending, and abrasive water jet cutting. The enterprise is still at the development stage, but there are a number of issues that have been detected and summarized in Appendix A Table A1. The analysis completed in this paper aims to determine whether the issues detected at Laser Technologies JV OOO are primarily related to organizational planning.

In the current market relationships, organizational planning is an important cornerstone of business development [4,5]. The current prices for all products and resources are freely set by competing manufacturers and consumers [6,7], and each business individually decides what products they should manufacture in the upcoming planning period and in what quantity [8,9]. As a result, the planning process provides the necessary balance between the manufacturer and consumer of a given product, the market demand for goods and services, and the supply from the manufacturer [10]. The essence of organizational planning involves the scientific justification of upcoming economic development goals and forms of economic activity as well as choosing the best methods for the implementation thereof. This choice is made by gaining a complete understanding of the type of product, service, or work in demand in the market, the volume needed, and the timeframes in which they should be released [11,12]. The indicators of production, distribution, and consumption which will support achieving the set qualitative and quantitative goals through the full use of limited resources must be determined [13]. Planning also involves the development of a set of measures which determines the sequence in which specific goals should be achieved, taking into account the capabilities of effective resource use by each production unit and by the business as a whole [14,15].

Product quality planning is the process of developing and adopting justified decisions on the release of goods with the quality indicators necessary at a certain point of time or over a period of time [16]. The goal of this process is to ensure that products have a quality level that meets existing norms and parameters and to determine areas in which product quality can improve [17]. Product quality planning must be based on evidence-based forecasts of the needs of the internal and external market. Product quality planning is a comprehensive process which must be carried out at various levels of management and in different stages of the product life cycle, including design, manufacturing, and operation [18]. Plans to improve quality should be supported by the necessary material, financial, and labor resources, and planned measures and indicators to improve quality [19] should be carefully justified through economic efficiency calculations [20]. Product quality planning based on QFD methodology in the laser processing of metals has not been studied yet. Most research in this field is devoted to methods of improving equipment, production tooling, and control.

Due to the lack of research papers dealing with this problem directly, the papers covering aspects of the application (research) of QFD in other areas were considered, in particular those describing the research on this method by shipbuilding and automotive companies in Japan, then in the United States, Europe, Korea, China, Taiwan, Brazil, Australia, etc. The literature sources [21–24] to which the authors of this article refer are devoted to the study of the QFD method, the comparative analysis of QFD models, and the review, analysis, and codification of the literature on advanced QFD models. The present article also draws from a range of sources devoted to the study of the QFD method in various industries, such as the automotive industry [25], aerospace [26], mechanical engineering [27], telecommunications [28], electronic engineering [29], etc.

Recent advances in the research and application of the QFD method are related to work in the field of services and integrated results, such as the product–service system (PSS) [30]. In Russia, the first introduction to the QFD method took place after the publication of articles by J. McElroy, and the study and application of this method in the Russian industry are reflected in the literature [31–33]. The lack of research papers on the application of QFD in the laser processing of metals is associated with a poor elaboration of the basic parameters of laser processing and a link with consumer requirements taken into account when planning the quality of products. With this approach, the present paper was written to solve issues detected at Laser Technologies JV OOO. The goal of this paper was to improve the quality management system (QMS) at Laser Technologies JV OOO through product quality management with the application of new methodologies. These studies are based on improving the quality management system (QMS) of the enterprise by improving the quality of manufactured goods manufactured by Laser Technologies JV OOO while developing the process "Product quality planning with QFD" to master the quality function deployment (QFD) methodology based on open innovation [34]. Open innovation in manufacturing is of great importance and links changes in scientific knowledge, technological capabilities, product design and production, and markets [35]. The use of open innovation is relevant for different areas, for example, additive manufacturing [36], the manufacturing industry [37], when developing new products for small and medium enterprises [38], open innovation in small and medium-sized enterprises [39], applying open innovation to sustainability [40], open research and development and open innovation [41], etc.

In connection with the above, to achieve this goal, the following tasks have been solved: comparison, and the selection of advanced domestic and foreign quality management methods to improve the planning process for product quality and enterprise activities (Section 2); development of a product quality planning process based on the selected method (Section 3); development of a modification of the "quality house" using the example of a part of a certain type (Section 3); development of estimates for an improved product quality planning process (Section 3); research on the significance of open innovation (Section 3); analysis of the results obtained, assessment of their practical significance, and dynamics of open innovation (Section 4); and conclusions (Section 5).

2. Materials and Methods

To achieve the goal of this research, we compared and contrasted the leading QMS methods applied in Russia and abroad—so-called new and additional statistical methods such as goal analysis, cost analysis, performance indicators, reference points, quality function deployment, tree diagrams, relationship diagrams, matrix diagrams, and sequence diagrams.

We examined the following QMS methods applied in the automotive industry:

- Production part approval process (PPAP) (the process of approving the manufacture of automobile parts);
- Advanced product Quality Planning (APQP) (quality planning in the development and manufacture of automobile parts);
- Failure mode and effects analysis (FMEA) (analysis of the forms and effects of failures);

- Measurement system analysis (MSA);
- Statistical process control (SPC);
- Quality system assessment (QSA).

Our analysis showed that before any of the aforementioned QMS methods can be applied, they must be taught to the technical and commercial divisions of manufacturers, which requires a great deal of time and investment [42]. We chose the QFD process to improve the quality management system. Its introduction and implementation are most appropriate for businesses such as Laser Technologies JV OOO, since the enterprise offers small batch (up to 5000 pieces) or one-off production, and the produced goods are used not just in the automotive industry, but across a wide range of industries.

The QFD method is one of the most effective methods of market analysis. It is currently the most powerful method for transforming consumer demands into technical characteristics in product quality. It is used to improve currently manufactured goods and in the development of the next generation of goods. The QFD method is a sequence of measures implemented by the manufacturer to convert quality indicators into technical requirements for goods, processes, and equipment. This system guarantees that consumer demands drive the development and manufacture of goods [42]. Quality planning and quality design occur in the early stages of the QFD method and continue until the product is "deployed" [43].

This method can result in the development of systems which are arranged by priority and link together the process of product development, guaranteeing the product quality demanded by consumers [44]. The main principle of QFD is to guide the development of products based on consumer demands. There are many formats of QFD, the most significant difference between them being the depth of analysis [45]. Quality function deployment, in a broad sense (or comprehensive QFD), is a combination of two formats: quality deployment and quality function deployment in a narrow sense. Quality deployment is a focus on the product and the deployment of the demands of the consumer alongside important factors of product manufacturing such as technologies, cost, reliability, etc. Quality function deployment, in the narrow sense, is a focus on processes and quality deployment according to the activities (functions) of the organization. The quality of the product is determined by the level of performing these functions [46]. Figure 1 shows comprehensive QFD—the simultaneous deployment of quality, technology, cost, and reliability across the whole project for the creation of products and across the organization as a whole [45].

The success of deploying the desires and needs of the consumer depends on the degree to which the quality of the manufactured product, as "imagined" by the manufacturer, meets the expectations of the consumer. Consumers, as a rule, do not express all of their expectations of the value of the manufactured product, as they consider some of the expectations to be self-explanatory, meaning that the manufacturer will surely take them into account during production. This is why the manufacturer, when forming the "imagined" quality, which they believe will match the expectations of the consumer, must first and foremost have a clear understanding of the quality profile for the manufactured product [47].

A quality diagram, or the house of quality (Figure 2), serves to translate the needs of the consumer into the language of the manufacturer. A fully developed quality function includes four stages of tracking the customer demands and needs (Figure 3): (1) product planning; (2) component development; (3) process planning, and (4) production planning. In the product planning stage, the manufacturer takes the information obtained from market research and transforms the consumer demands into quality indicators for a product and develops the product concept. The first step results in the identification of the product characteristics that meet the demands of the consumer and support the product's competitiveness on the market [48].

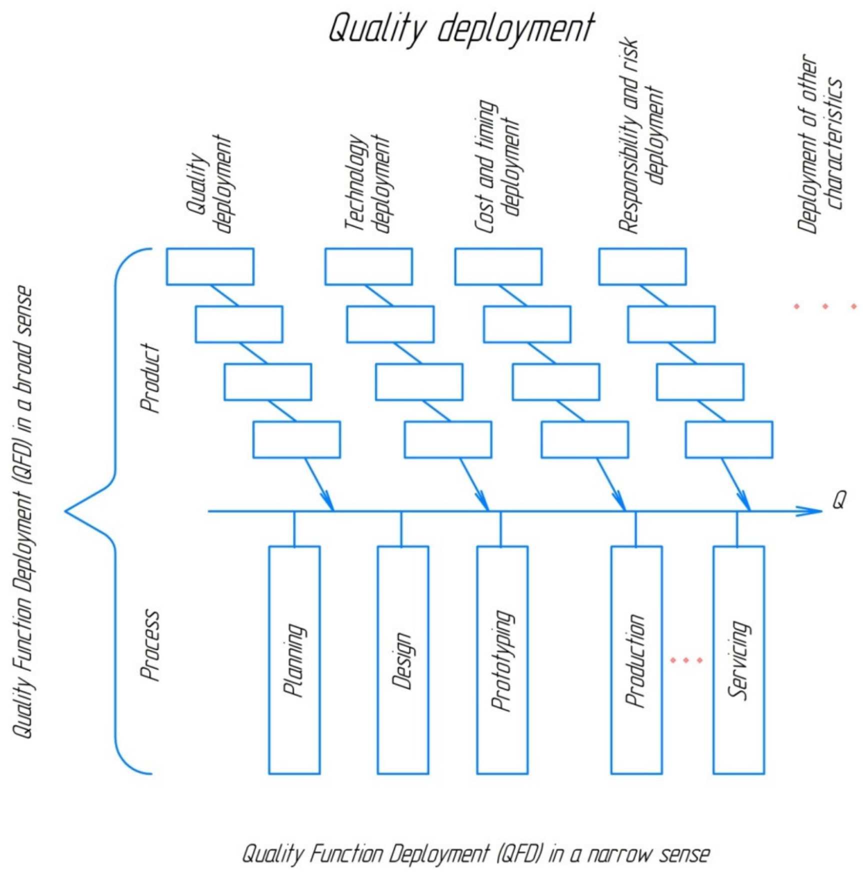


Figure 1. Comprehensive QFD.

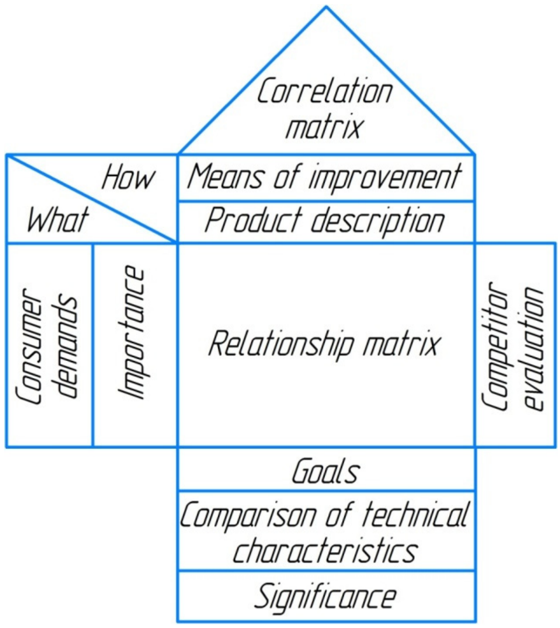


Figure 2. House of quality.

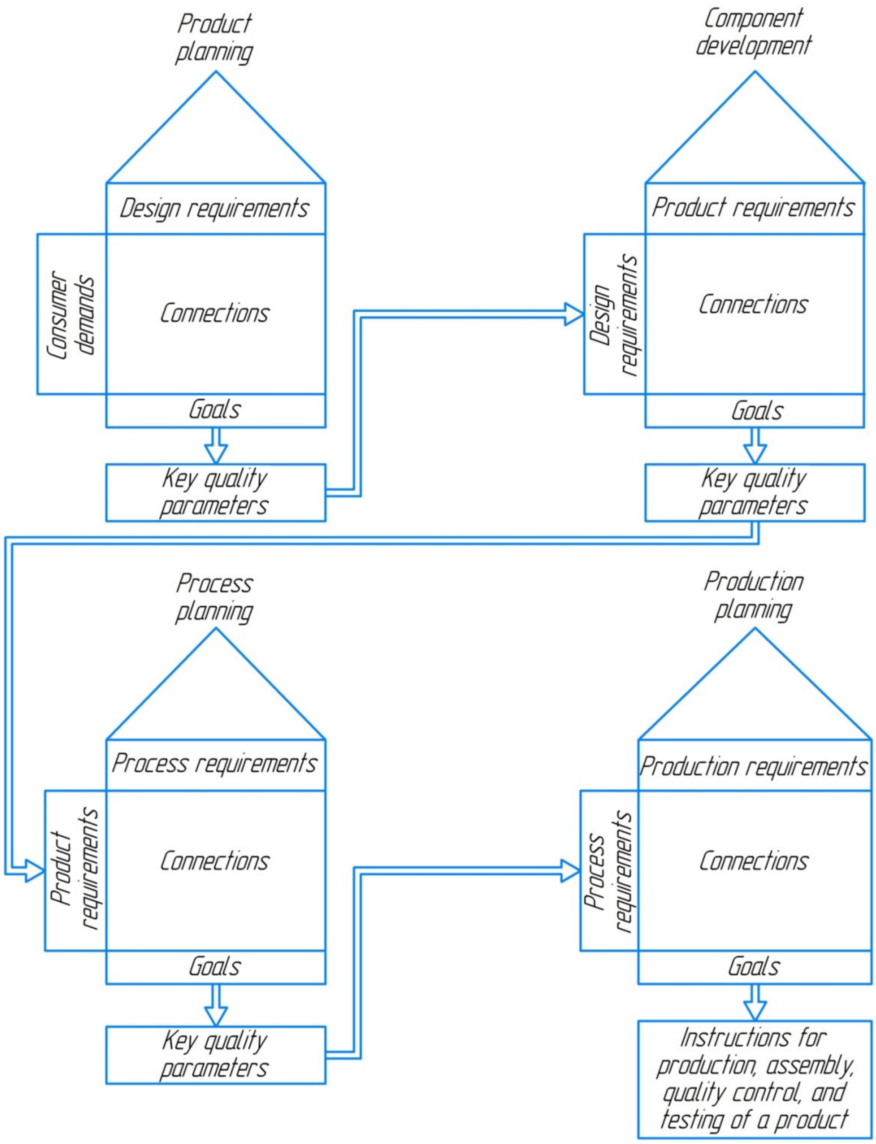


Figure 3. Schematic diagram of the comprehensive QFD process.

The component development stage involves the identification of the most critical components of the product, which will ensure that the manufacture achieves the customer requirements discovered in the first stage of the product's technical specifications. Upon completion of the second stage, the manufacturer should choose the project which most fully meets the demands of the consumer. In the process planning stage, technical requirements are transformed into a sequence of processes that will allow for the product to be manufactured as designed with the necessary characteristics. The process planning stage involves the identification of key parameters for each process and methods of controlling said parameters. For each process, a function cost analysis (FCA) is completed, which allows for the manufacturer to determine the most labor-intensive operations in the manufacture of the product and reduce the costs of their execution. Upon completing the FCA, the manufacturer identifies the technical process that allows for the necessary characteristics of the product to be realized at a minimal cost [49].

In the production planning stage, the manufacturer develops organizational standards and chooses quality control instruments for the manufacture of the product. The standards must allow for improvements to be made to the product upon detection of inconsistencies or complaints.

3. Results and Discussion

The authors developed a process for planning the quality of a pipe flange at Laser Technologies JV OOO based on the QFD method [50]. A flange is a pipe component or the connection point of pipes, reservoirs, embankments, etc. A flange is a flat steel ring or disc with holes for bolts or double-end bolts. Flanges support the strength and the tightness of connections.

Figure 4 shows a flange produced by Laser Technologies JV OOO through water jet machining on the Bars Jet cutter from 5-mm-thick grade 12X18H10T sheet metal. This is a slip-on flange. Slip-on flanges are placed onto the pipe and are welded on the backside. For this reason, the inside diameter of a slip-on flange is slightly larger than the outside diameter of the pipe. This flange is used on pipes with a nominal pressure of 2.5 MPa (25 kgf/cm^2) with an operating temperature of 120 °C. The developed house of quality for the flange (Sample 1) is presented in Figure 5 with consumer demands and engineering characteristics.

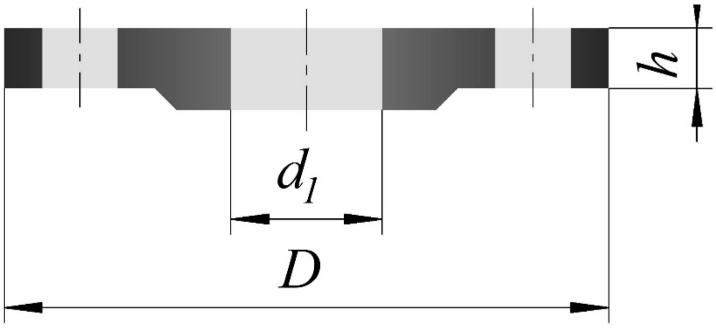


Figure 4. Slip-on flange.

Based on the report on the results of marketing research of a customer survey, the consumer requirements for Laser Technologies products were determined. When clarifying these requirements, the factor model of consumer satisfaction with the following consumer requirements was taken as a basis: (1) functionality: great strength, durability, wear-resistance, and lack of corrosion; (2) appearance: dimension, uniformity in thickness, quality of the working surface; (3) cost, affordable price. When clarifying customer requirements, the factor model of customer satisfaction was taken as a basis and the following customer requirements were obtained: (1) great strength; (2) durability; (3) wear-resistance; (4) lack of corrosion; (5) dimensions; (6) uniformity in thickness; (7) quality of the working surface; and (8) affordable price. Using a pairwise comparison matrix, it was further revealed that the most important consumer requirement was "durability", and the least important one was "uniformity in thickness". At this stage, the technical characteristics of the product were developed, for example, (1) bending strength; (2) dimensional accuracy; (3) parallelism of end surfaces; (4) surface roughness; (5) lack of shells and inclusions; (6) shape accuracy (roundness); (7) spacing accuracy (alignment, wobbling); (8) strength properties; (9) chemical properties; and (10) metal grade.

To determine the dependencies of consumer requirements, the house of quality matrix table was built (see Figure 5).

In the present article, the authors evaluated:

1. The importance of each consumer requirement R (1—not at all important, 2—slightly important, 3—important, 4—fairly important, 5—important);
2. The link between the consumer requirements and the technical characteristics of the product P (•—strong (9), ○—average (6), Δ—weak (3)).

The roof of the house of quality shows the correlation between the product's technical characteristics: •—strong positive, ○—positive, x—negative, xx—strong negative.

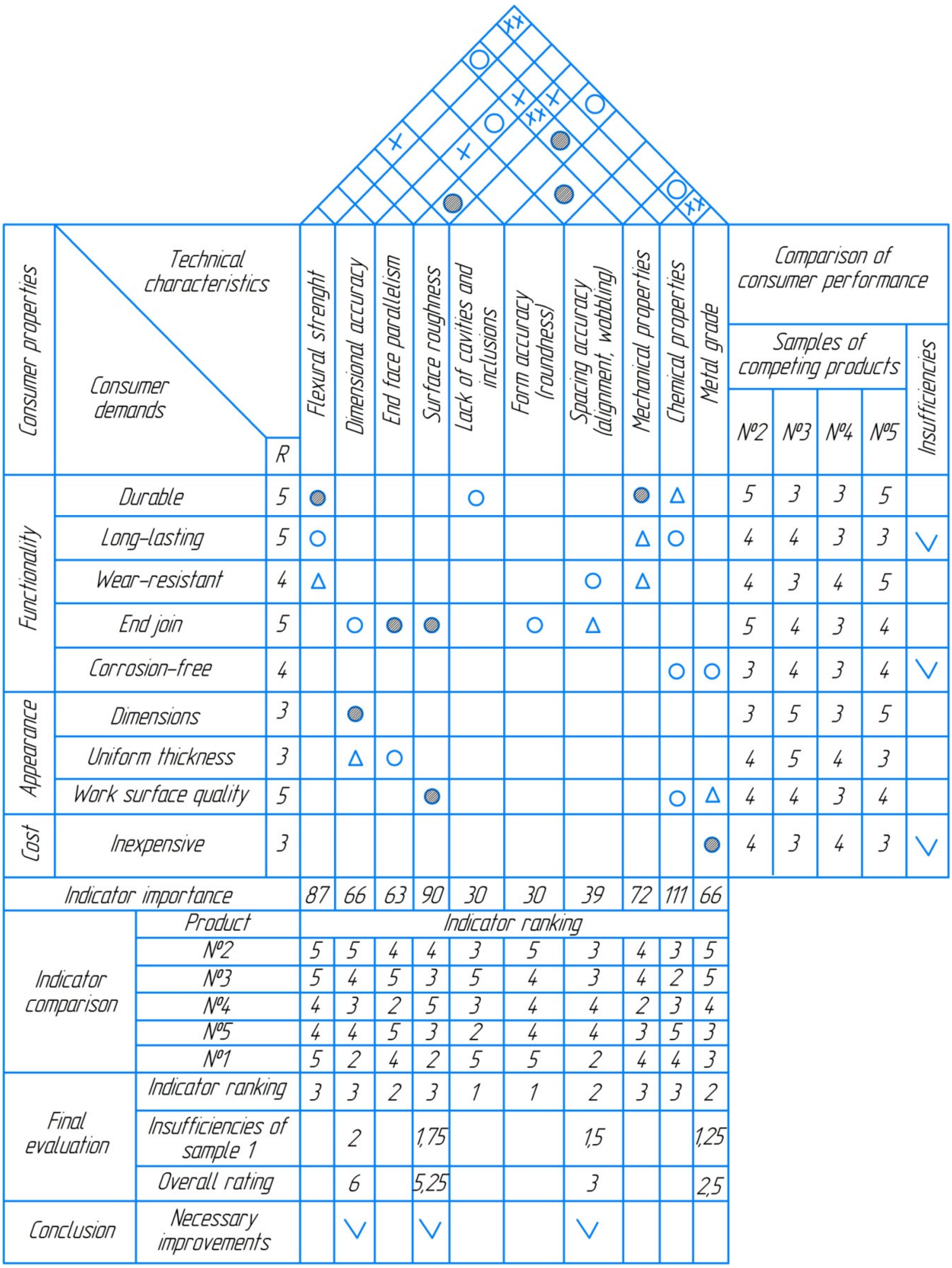


Figure 5. House of quality for a slip-on flange.

The right side of the house of quality presents a comparison of the ratings of the importance of consumer requirements for analogous parts from different manufacturers (Sample 2, 3, 4, 5). The level to which a consumer requirement is met was determined: 1—weak, 2—acceptable, 3—average, 4—good, 5—excellent. The rating was determined by comparing relative quality indicators and confirmed by market research. Based on this information, the authors came to the following conclusion about the shortcomings of competitor goods in the following consumer requirements: durability, lack of corrosion, and affordable price.

In the lower part of the house of quality, we evaluated the importance of each technical characteristic (through calculations) and compared the significance of technical characteristics for all samples being examined (expert evaluation): 1—weak, 2—acceptable, 3—average, 4—good, 5—excellent.

The final assessment determines the importance of a given technical characteristic of the part: important—1; fairly important—2; very important—3. The non-competitiveness of Sample 1 was estimated as the relationship between the average rating of the technical characteristics of Samples 2–5 and the rating of the characteristics of Sample 1. Then, the authors calculated a composite rank for Sample 1, combining the insufficient competitiveness of Sample 1 with the ranked importance of the part's technical characteristics. Using the QFD method, it was concluded that it was necessary to improve the quality of Sample 1 in the following characteristics: dimensional accuracy, surface roughness, and spacing accuracy (alignment, wobbling). The developed process for product quality planning with the application of QFD is displayed as a block schematic, algorithm, and responsibility matrix in Table 1. In the lower part of the "house of quality", an assessment of the importance of each engineering characteristic (by calculation method) is given.

$$I_I = \sum_{i=1}^{n} P_i \times R_i, \tag{1}$$

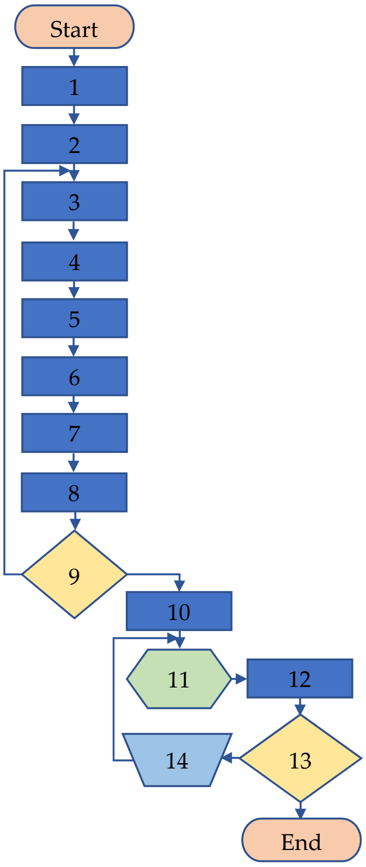
where: I_I—index of importance; P_i—the i-th relationship between customer requirements (CR) and engineering characteristic (EC); and R_i—i-th rating of the importance of customer requirements (CR). Using an expert assessment method, a comparison of the values of technical characteristics of all samples under consideration was made by rating them on a scale of 1 to 5: 1—poor, 2—fair, 3—good, 4—very good, 5—excellent. To take into account the influence of competitors on the product of the enterprise, their state of business was identified. For this purpose, consumer properties were compared on the right side of the house of quality, and the technical characteristics of the proposed product and those of competitors were compared at its bottom. Based on the analysis of consumer preferences for each consumer requirement and technical characteristics, the degree of satisfaction with consumer properties was determined and the values of technical characteristics were compared (by an expert assessment method); that is, the enterprise profile and the profile of competitors were formed (rating scale: 1—poor, 2—fair, 3—good, 4—very good, 5—excellent). At the final stage of assessment, the importance rating of product technical characteristics was developed using a scale of 1 to 3: important—1; fairly important—2; very important—3. Lack of competitiveness (LC) of the Laser Technologies' product is assessed by the ratio of the average rating of technical characteristics of competitors' samples to the rating of the indicators of the Laser Technologies' product:

$$\text{LC} = \frac{\overline{x}(\chi_i \in (1;n))}{R_p}, \tag{2}$$

where $\overline{x}$ is the arithmetic mean of technical characteristics of competitors' samples; and R_p is the rating of the indicator of own production. A generalizing rating (GR) for the Laser Technologies' product was calculated at the foundation of the house of quality (bottom row). The rating summarized the disadvantages of the Laser Technologies' product competitiveness according to the indicator importance rating (P_i) of the product quality:

$$\text{GR} = LC \times P_i \tag{3}$$

Table 1. The process of planning product quality with the application of QFD.



Responsibility	Responsible Party
1 Determining consumer demands	Head of marketing
2 Ranking consumer demands	Quality assurance manager
3 Developing technical characteristics	Engineers
4 Determining the relationship between consumer demands and technical characteristics	Engineers
5 Determining the correlations between technical characteristics	Quality assurance manager
6 Determining the weight of technical characteristic indicators	Quality assurance manager
7 Evaluating the importance of each indicator	Head engineer
8 Evaluation of the influence of competitors	Quality assurance manager
9 Adopting solutions	Head engineer
10 Formation of a part quality report	Quality assurance manager
11 House of quality analysis	CEO of Laser Technologies JV OOO
12 Final evaluation and determination of the importance of improving characteristics of the produced flange	CEO of Laser Technologies JV OOO
13 Determining if the house of quality is up to date and applicable	Head engineer
14 Making changes, adjustments	Quality assurance manager

The lack of competitiveness of sample No. 1 was assessed by the ratio of the average rating of technical characteristics of samples No. 2, 3, 4, and 5 to the rating of characteristics of sample No. 1. A generalized rating for sample No. 1 was calculated, combining the competitiveness disadvantages of sample No. 1 by the importance rating of technical characteristics of the part. Several methods were used to solve the main tasks of this research: analytical methods, searching internet resources, comparison, cost of quality (COQ), functional process modeling (IDEF), quality function deployment (QFD), and advanced product quality planning (APQP).

Using the quality function deployment (QFD) method, it was concluded that it is necessary to improve the quality of sample No. 1 in terms of the following characteristics: dimensional accuracy, surface roughness, and accuracy of relative position (concentricity, runout).

The developed product quality planning process using QFD is reflected in the flowchart, algorithm, and responsibility matrix in Table 1.

4. Summary

Analysis of the developed "quality house" by the QFD method using the example of a "flange" type part made it possible to obtain results on the need to improve the quality of sample No. 1 according to the following characteristics: dimensional accuracy, surface roughness and relative position accuracy (concentricity, runout). The developed modification of the method of structuring the quality function using the example of the flange part manufactured by Laser Technologies JV OOO takes into account the results of the qualimetric assessment of samples and the correlation analysis of quality indicators. The originality and value of the proposed model, in addition to the investigated and developed process of planning the quality of laser metal processing using QFD, allows the expansion of the field of applicability of the QFD methodology from a scientific point of view, allowing stronger dynamics of open innovation and achieving the following new managerial and scientific results:

1. Makes it possible to provide a systematic approach to determine the needs or requirements of consumers for product quality and outline ways to satisfy them (to allow placing a large amount of information in a compressed form convenient for efficient and clear analysis; allows a reduction in the development time by 30–50%);
2. Allows you to identify the expectations of consumers in the most effective way, highlight key requirements among them, and translate them into products, optimizing the technical characteristics of the project according to the degree of customer satisfaction;
3. Makes it possible to provide assurances that consumers will accept and use new products even before they are produced and placed on the market;
4. Makes it possible to ensure a large market share due to the earlier appearance on the market of products with a higher level of quality;
5. Makes it possible to provide a clearer definition of the processes of the organization itself;
6. Provides an opportunity for optima distribution, and therefore an opportunity to use the organization's limited resources most effectively to ensure both tactical and strategic goals are reached.

The effectiveness of the improved planning process is achieved by applying a systematic approach to identify and meet customer requirements and expectations for product quality while optimizing the technical characteristics of the project. Thus, the use in this work of analytical methods for calculating estimated indicators and their criteria, methods of computer technology, search methods for working with Internet resources, comparison methods, methods for assessing quality costs according to functional cost analysis (FCA), functional modeling methods (IDEF), the quality function deployment (QFD) method, the advanced product quality planning (APQP) method, methods of statistical thinking, etc., made it possible to achieve the set goal to improve the quality management system (QMS) of the enterprise.

The improvement of the QMS using open innovation with the results of the work made it possible to implement the principles of TQM in accordance with the international standard ISO 9000: 2015:

- The principle of "customer orientation" with an increase in customer satisfaction and loyalty, with an expansion of the consumer base, accompanied by an increase in income;
- The principle of "employee interaction" with the creation of teams and increasing the involvement of employees in improvement activities;
- The principle of "process approach" in the implementation of process controllability, reduction in cross-functional barriers, and efficient use of resources.
- The principle of "improvement" with strengthening the incentive to innovate, improving the results of processes;
- The principle of "evidence-based decision making" with improved decision making, increased efficiency and effectiveness of work and the use of statistical thinking.

The practical significance of the research results lies in the achievement of the following qualitative and quantitative development results: the volume of external and internal failures was reduced by 12%, the development time for new products was reduced by 9%, and the cost of information resources was reduced by 11%. Quality control in the production process was reduced by 7%; the complexity of the process control was reduced by 25%; and the stability of the process increased by 25%. The expected economic effect for the billing period, with a constant volume of output, is RUB 298,173.

5. Conclusions

The goal of this work was achieved—the quality management system was improved through the effective management of innovation and product quality planning using the latest methodologies in the conditions of "Laser Technologies". These studies were performed in order to improve the company's QMS by improving the quality of manufactured products when developing the process of product quality planning (QFD) and mastering the quality function deployment (QFD) methodology and using other innovative, advanced quality management methods and implementing the principles of Total Quality Management (TQM).

The results of the studies and the dynamics of open innovation make it possible to expand the field of applicability of the QFD methodology from a scientific point of view. At the same time, the added scientific value of the published research results and future research in this direction consists of the development of QFD technology in a previously unexplored field of application, and it ensures effective management of the innovative activity of the laser technology enterprise, as well as the metalworking of the engineering industry enterprises as a whole.

The relevance of this study, its scientific novelty, and practical significance for subsequent professional, academic research, and the future of scientific literature allows benefits of open innovation and significant theoretical contributions to be achieved, which consist of the following:

- Competitive advantages are provided for both existing and newly developed types of products;
- Provides a systematic approach to determine the needs and requirements of consumers for product quality and creates ways to satisfy them; customer expectations are most effectively identified and translated into optimized product specifications;
- A large market share is ensured due to the earlier appearance of products with a high level of quality;
- The processes of the enterprise's QMS are more clearly defined;
- Production resources are optimally allocated and used to ensure the tactical and strategic goals of the enterprise.

The added value achieved open innovation, and the results of this study can be seen in the literature below [43–49].

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Issues detected at Laser Technologies JV OOO.

Issues Formulated by the Company's Management	Approaches and Methods Applied by the Company's Management to Resolve Issues	True Source of Issues
1 Reduced quality of materials arriving from suppliers.	Assigning a warehouse attendant full responsibility for visual quality control.	No purchasing department. No partnership with the suppliers on creating an effective QC system.
2 Insufficient managers. Poor training of managers. High personnel turnover.	Constant selection and replacement of managers.	No clear requirements for the work completed by managers. Insufficient control of management activity, which occurs on occasion.
3 Confusion from the constant reworking of the organizational structure	The frequent firing of individuals in management positions. Responsibilities are passed on to staff for activities which are either above or outside of their job duties.	No reworking of management principles. Use of the most ineffective form of organizational structure (functional) in many Russian businesses.
4 Disregarding the services of certain (small) segments of the consumer market.	Strengthening of the promotional department.	Incorrect promotional information. Ignorance of the issues and desires of customers. Lack of customer feedback.
	Certification for quality systems per ISO 9001.	Lack of marketing research: the list of consumers, sectors, and market niches that are occupied by products that are not defined.
	Focus on priority consumer (large).	
5 Dilapidated equipment	Expensive repairs of old equipment and acquisition of new equipment	The productivity of the production area and equipment has not been determined. The expected efficiency of equipment has not been determined.
6 Lack of a friendly team atmosphere among staff	(No actions taken)	Inconsistencies and differences in the goals held by employees. Ignorance of the company's strategy.
7 Lack of information among staff about the work of the company. No transparency about the activity of management.	(No actions taken)	No feedback from staff. No consideration for the opinion of the staff.
The following issues, at first glance, are unrelated, or they may seem like the result of all of the aforementioned issues. However, executive management names them as factors which get in the way of developing the management system: "frequent rejection of factory goods involves searching for the guilty party, which leads to a system of fines against company personnel. As a result of these methods, personnel cannot participate in improving product quality; they sabotage the process of creating a system for quality control at the business".		
8 Expenses from the rejection of goods (low quality of services offered). Lack of stimulus to improve efficiency among personnel (low wage, fines).	Searching for parties guilty for rejection of goods and harsh systems of punishment for personnel (wage deductions). Searching for new clients. Repair of old equipment, acquisition of new equipment. More strict process control in the manufacture of goods.	The inversely proportional relationship between the compensation received and level of responsibility among personnel and management, which makes it impossible to improve the quality of produced goods or build an effective system of management.
		Total lack of both quality planning and control.
		Inconsistencies in the quality costs system: many expenses on poor quality are not included in calculations.

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