DOI: https://doi.org/10.30932/1992-3252-2020-18-136-157

Development of the House of Quality for Rail Transportation Market

Lavrov, Ilya M, *Russian University of Transport, Moscow, Russia*.*

Ilya M. LAVROV

ABSTRACT

The article discusses the features and application of the technology of deployment of quality functions. The objective of the article is to present an efficient methodology allowing transport companies to make management decisions in the field of improving the quality of transport services provided to cargo owners. The technique was developed based on the House of Quality model (matrix) in the framework of the Total Quality Management (TQM) concept.

Using logical, graphic, factorial, comparative, balance methods and considered technology the article describes in detail the structure and the procedure for constructing the House of Quality matrix within the process of analysis of rail transportation companies and focusing on the features and criteria of customer preferences in the field of rail freight transportation.

Actual examples were used to show particularities of provision of rail transportation services. The developed technique and recommendations may be useful for transport companies to proceed with multiple factor analysis if their activity in the field of quality management, to assess efficacy and identify priorities while making decisions aimed at increasing quality of transportation services.

Keywords: *total quality management (TQM), quality functions deployment (QFD), house of quality (HOQ), railway transport, transport services, cargo transportation.*

---

*Information about the author:
Lavrov, Ilya M. – Ph.D. (Economics), Associate Professor, First Deputy Director – Head of the Training office of the Institute of Economics and Finances of Russian University of Transport, Moscow, Russia, ilya02lavrov10@yandex.ru.

Article received 21.11.2019, accepted 13.02.2020.

For the original Russian text of the article please see p. 136.

Background.

In modern conditions, the quality of services provided to customers is one of the most important factors determining the success of transport companies in competition for the client.

Since transportation, and particularly railway transportation services, are in significant demand among cargo owners as customers, transport companies are most interested in finding new ways to improve the quality of service.

Railway transport has a powerful potential for improving the quality of transport services through implementation of promising projects introducing new transportation and information technologies, developing transport infrastructure, enhancing engineering facilities. However, it is necessary to analyze efficacy of those projects to confirm conformity of the undertaken measures with the needs of cargo owners.

According to the modern universally accepted Total Quality Management (TQM) concept, it comprises as the fundamental element the approach based on quality assessment by customer, while consumer involvement in this process is a core factor [1; 2]. Customer involvement, analysis of their feedback is considered the key to the TQM effective operation. The system for improving product quality involving analysis of customer feedback is associated with a technology for quality functions deployment (QFD) during design and manufacture of products or services. It is based on the matrix principle, as well as on the application of economic and mathematical calculations to determine priority of management decisions.

According to the logic of constructing processes using QFD technology, all functional departments of a transport organization should be involved in the technological process from the first day, which is the main goal of TQM [3, p. 3]. So, the QFD technology methodically develops approaches to total quality management.

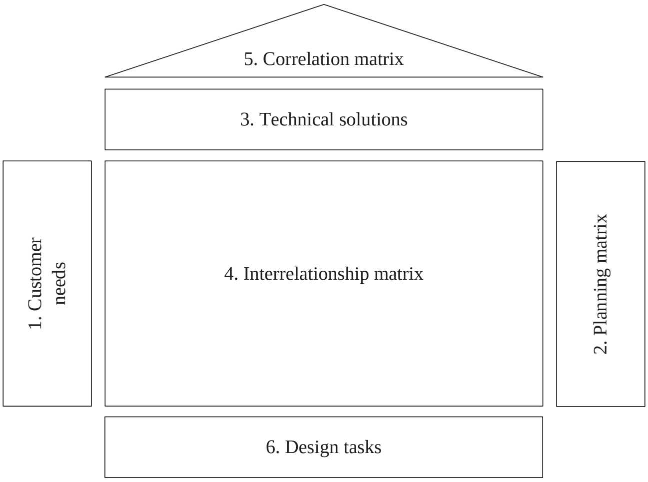
According to this technology, one of the ways to achieve customer satisfaction and continuous growth in the effectiveness of the organization is to understand customer's desires and needs and to apply them in design and production. A significant contribution to development of QFD technology was made by prominent Japanese expert Dr. Yoji Akao, who in 1966 combined quality strategies with the developed technology for quality functions deployment [4, p. 24]. According to his approach, the client (potential user of transport services) becomes part of the team that carries out transportation. This technology indicates the line of action for designers and planners that allows them to focus on the features of a transport service which are the most important for a client. The QFD technology workflow consists of the following steps:

1. identification of consumer needs, which are called «The Voice of the Customer» (VOC);
2. identification of technical solutions (measures) that will allow to bring transport products as close as possible to the point of the fullest satisfaction of the VOC;
3. establishment and optimization of the process of developing transport products based on the first two stages, as well as setting priorities for technical solutions and identifying specific tasks for implementation [2, p. 311].

Thus, the main operating requirement of QFD technology is that each transport company should know the desires and preferences of its cargo owners and should convert them into components of an offered transport service to fully satisfy the VOC [5; 6]. Whenever possible, a transport company should carry out an intermediate testing of its services, which contributes to a more complete understanding of which of the decisions made bring the greatest contribution to meeting the needs of the cargo owner.

This statement determines the *objective* of this article, which is to consider the basic methodology for making managerial decisions in the field of improving the quality of services in the transport market based on the development of a special model.

The described TQM concept and QFD technology as its structural component, make foundation for building a quality assessment model, which is the House of Quality (HOQ) – a set of interconnected matrices, each of which describes a certain stage of the study. It is one of the most modern and universal models for analysis and evaluation of product quality. The relevance of this study that used logical, graphic, factorial, comparative and balance *methods* is to analyze applicability and adaptability of the model to the activity of transport companies.



Pic. 1. Structure of the House of Quality with a numbered sequence of included matrices.

Results

The House of Quality model (HOQ), as mentioned above, is a set of interconnected matrices that have a specific sequence once they are built. Those matrices are used for comprehensive analysis of external and internal factors influencing the quality management process, and for further development of recommendations (specific technical solutions). The implementation efficiency (feasibility) of those technical solutions can also be determined in advance.

The HOQ model is named so its structure is similar with the appearance of the house (Pic. 1).

According to Pic. 1, the quality house consists of six matrices [7, p. 434]:

• Matrix of identification of customer needs (Customer needs);
• Planning matrix;
• Matrix of development of technical solutions (Technical solutions);
• Interrelationship matrix;
• Correlation matrix;
• Matrix of setting of design tasks (Design tasks).

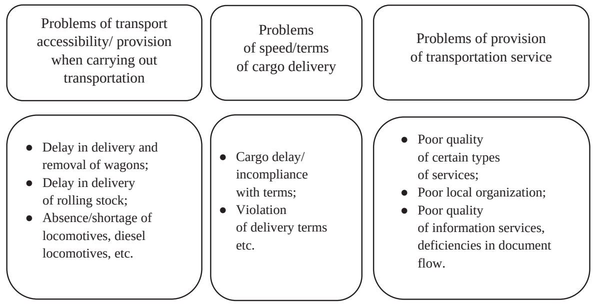
When compiling HOQ, all matrix components are filled in a formal sequence from 1 to 6. To consider the stages of building HOQ, we use a conditional example of functioning of a transport company. All numerical values used in the examples below are conditional.

Matrix 1: «Customer needs»

Our hypothetical company is engaged in railway transportation of goods. The company is not satisfied with its current market position and intends to update its offers to increase its market share. The company understands that to do this it must carry out the transportation process according to the requirements of potential cargo forwarders. The company plans to implement QFD technology.

Before starting to provide transport services, corporate employees should carefully work with potential cargo owners in order to determine what exactly they want to get from the transport company and, perhaps, to find out what does not suit potential customers. There are many ways to obtain this kind of information from cargo owners, including market analysis, establishment of focus groups, conducting personal, telephone, online surveys, sending questionnaires, also involving buyers-users of transport services of other companies, etc.

As soon as a team of company employees has collected sufficient information about characteristics and features of transport products cargo owners do need, the received information should be processed for further analysis. To speed up processing of a huge array of consumer opinions, the data obtained should be sorted into groups depending on their priority in terms of meeting the most important customer needs. For this, an QFD technology tool is used, which is called Affinity Diagram. Filtering a large amount of data into a sample that would represent the basis of the results of VOC survey is carried out with the analytical methodology called Affinity Diagram and through a discussion of the results by a team of employees [8].



Pic. 2. Affinity Diagram: analysis of problems, leading to a decrease in cargo transportation volume.

Pic. 2 shows the Affinity Diagram developed by a team of employees [9]. The purpose of its development was to organize the process of analyzing the input information of cargo owners (which transport services they select and want to purchase, considering the fact that the carrier has not offered them and that they are not satisfied with the current services), of revealing the reasons for the decrease in demand for transport services of the company.

The next tool to be used is Tree Diagram. In this case, it is used simply to refine the results of Affinity Diagram, to compile a final list of needs of cargo owners and fill in the matrix of consumer needs. Pic. 3 presents a fragment of Tree diagram, which was developed to solve the problems indicated in Pic. 2.

In practice, the working team summarizes the list of customer needs, keeping the key, most significant needs. The final list of customer needs, covering a complete set of questions, can be up to 20–30 points, depending on the situation. These needs imply what customers would like to see (or adjust) in the transportation process. Needs characterize what a transport company should strive for in order to provide a transportation service that will be of value to customers [10]. This list, representing the VOC, is the basis for filling in the first matrix of HOQ.

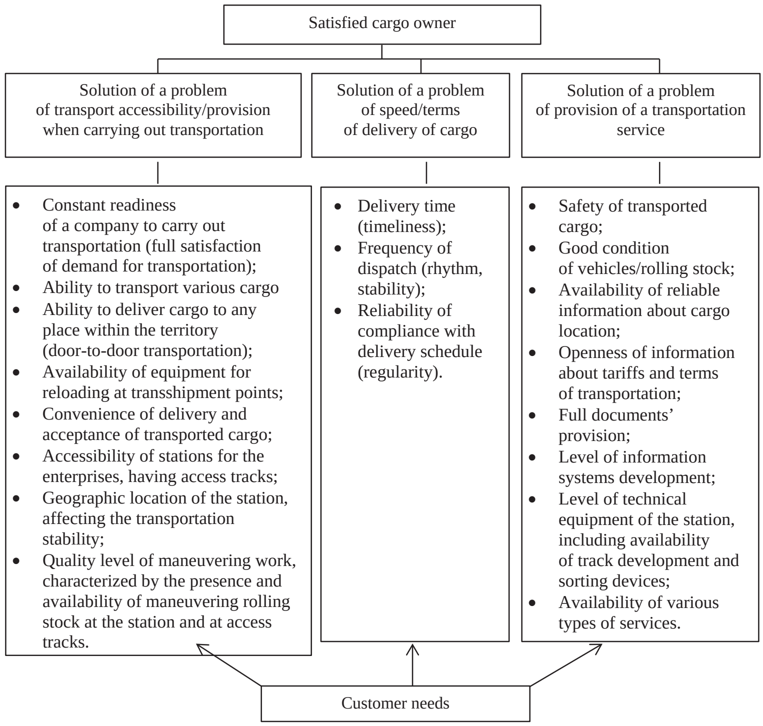
The analysis of this matrix also includes an assessment of significance of the identified needs for cargo owners themselves. The significance level is rated on a scale of one to five points, where five is the highest priority. This information can be obtained at the stage of the survey of cargo owners. But since it is impossible to get an assessment of the need according to significance scale from all the cargo owners, the working team should do everything possible to independently evaluate and set priorities, based on a representative sample of interviewed cargo owners. Significance values are entered into the column «Level of significance for the client».

Matrix 2: «Planning matrix»

Then, it is necessary to collect and analyze data on satisfaction of cargo owners regarding the transport services of the considered transportation company and competing companies, to develop a planned targeted satisfaction assessment of a transportation services which is being prepared, and to calculate improvement coefficients and allocate points of sale.

First, a comparative analysis is carried out to compare services of the analyzed transport company and the services of competitors. At this stage, it is important to know the customer satisfaction rating regarding competitors, since it will help the transport company to identify what it needs to do to make its transportation services more attractive than those of its competitors. To get this information, the working team organizes a focus group to compare quality of transportation services. It is also possible to organize questioning among customers who use transportation services of analyzed company along with the services of competing companies. In both cases, respondents should be asked to rate transport services regarding each characteristic listed in the customer needs matrix using a scale from one to five points. The received information is entered into the planning matrix. (Examples provided here and further on are shown also in Pic. 4).

The planning matrix will also display the desired degree of customer satisfaction with the transportation service for each criterion of customer's needs (target customer rating). The same scale from one to five points is used. The practical goal is to implement a transportation service that will satisfy customers but will not



Pic. 3. Tree Diagram: identification of key needs of cargo owners from the total sample of answers.

be too costly for the company. However, this does not mean that improvement of some other needs should not be considered. A transport company should be sufficiently competitive by all consumer parameters, but it does not have to be the most expensive in terms of financial costs [11; 12]. The working team develops a target customer rating for each need and enters the set values into the planning matrix.

Then the working team calculates *the improvement coefficient* for each need for a transportation service. Equation for improvement coefficient with a scale of one to five points:

Improvement coefficient = {(Target customer rating – Evaluated customer rating) • 0,2} + 1. (1)

A strategic marketing factor, sometimes called a «*point of sale*», can also be included in the planning matrix. A point of sale is a number from 1 to 1,5 that is used to focus on customer needs. This is an assessment of marketing significance of the need to promote a transportation service, and therefore it is used together with the assessment of the level of significance for the client and the improvement coefficient in calculating the total weight of customer needs. A point of sale with a value of 1 will not lead to a change in the total weight of customer needs. A point of sale with a value of 1,5 doubles the value of the total weight of customer needs compared to the value that was calculated based on the level of significance for the customer and the improvement coefficient. The working team develops data on the points of sale and enters them in the planning matrix.

Then the working team calculates the total weight of each customer need separately, according to the following formula:

Total weight = Level of significance for the consumer • Improvement coefficient • Point of sale. (2)

Then it is necessary to determine the value of the total weights of needs in percent, to better understand what share of the cost of improvement should be given to each of the considered customer needs. The percentage of total weight is calculated using the following formula:

% of the total weight = (Total weight/Sum of total weights) • 100. (3)

Thus, using the planning matrix and basing on the consideration of its constituent factors (*the significance level for the client* (shows how critical this need is for the client); *the improvement coefficient* (characterizes the necessary amount of efforts of the transport company to improve its transportation services to achieve the target level with the goal of full satisfaction of the need); the *point of sale* (characterizes the level of importance of this need in terms of marketing)) it is possible to calculate the total weight of a need. Based on the calculated percentage of the total weight, it is possible for the transport company to rationally distribute its financial and production resources to implement quality improvement measures.

For example, customer need for door-to-door cargo transportation has the highest total weight and the highest percentage of the total weight. For the transport company, this parameter will have priority in achieving the target rating of «5». The need for regularity and stability (rhythmic transportation) occupies the second place, and the need for constant readiness of the company to carry out transportation is in the third place.

Matrix 3: «Technical solutions»

The matrix of technical solutions development indicates how the transport company plans to respond to each cargo owner's need. This is sometimes called the «voice of the company». It should be noted right away that technical solutions do not represent the technical specifications of a product or a service [13, p. 1580]. Rather, these are improved or newly created product features that aim to better meet consumer needs. They can be measured in terms of satisfaction. Some of them can be measured by weight, force, speed, etc., others are measured by the criterion of «yes/no». Technical solutions should not be constraining, but quite flexible to allow the company to use all the creative ability to satisfy the need. As a guide to their development, the obtained results of two previous matrices are used.

Using Affinity Diagram or Tree Diagram will also help the working team focus on the characteristics and features of the transportation service (cargo transportation), as well as on the procedures and production processes that will help achieve the planned improvement. The difference here is that suggestions come from within the company, not from customers.

The development of proposals is repeated for all production tasks in order to form a list of elements from which the working team will finally select technical solutions that should be placed in the matrix of technical solutions.

Matrix 4: «Interrelationship matrix»

Once technical solutions are included by the working team in the structure of the House of Quality, a next step is to study the issue of how they relate to the needs of customers. The results will be shown in the interrelationship matrix, which links the matrices 1 and 3. For each cell making up the interrelation matrix, the working team should evaluate the degree of interrelation between each cargo owner's need and the corresponding technical solution. This is usually done using a significance scale of 1 to 9, with a higher value indicating a stronger interrelation. Sometimes the numbers are entered into the matrix, but symbols are also often used. For our example, we will use the symbols as follows:

◎ = 9 (strong interrelation);
○ = 3 (medium interrelation);
△ = 1 (weak interrelation);

An empty cell indicates the absence of interrelation.

To understand how to work with this matrix, let's consider the first need of the client «*Timely delivery of goods*». It is necessary to determine what technical solutions are relevant to fulfillment of this need.

In case of the conditional transport company being analyzed, interrelation can be tracked using technical solutions similar to those that have been implemented in Russian Railways holding company, e.g., introduction of the centralized Focus automatic system (Focus AS), a long-term system of the holding company's interaction with key shippers, and a change in the KPI system for employees. To understand how strong these interrelationships are, the working team should think it over and make a decision. Therefore, the result of this assessment may not be accurate, but approximate, agreed upon following the results of the discussion.

There is an empirical rule in QFD technology, according to which only about 15 % of interrelationship cells will show the relationship between customer needs and technical solutions. At the same time, there is another solid rule for filling in the interrelation matrix: *each row and each column must have at least one significance marker*. An empty column means that this technical solution is not able to satisfy any consumer needs. Spending any efforts on such technical solutions would be a waste of resources for the transport company, as customers would not find it useful. On the other hand, a horizontal line with empty cells indicates that a specific customer need is not solved in any way by the proposed technical solutions. It must be remembered that all of the listed customer needs should be considered in technical solutions, and any technical solution that does not meet the needs of customers should probably not be accepted for execution.

Matrix 5: «Correlation matrix»

When developing a product or a service, certain technical solutions will inevitably arise that can benefit each other (i.e., have a supportive or a positive correlation), and some will work against each other (i.e. become an obstacle or get a negative correlation). The transport company needs to know what correlation exists between the proposed solutions in order to correctly use supporting correlations and find compromises for those that interfere with each other. Lack of information about this may lead to the fact that a transportation service will not meet the requirements of cargo owners or will require expensive modernization. The goal of correlation matrix or «roof» of the House of Quality is to help understand it correctly from first sight.

Intersecting diagonal lines are drawn in a triangle on top of each column of technical solutions. Next, the type of correlation is determined (supporting, inhibiting or not having correlation) for each of the technical solutions in comparison with all other technical solutions. The supporting correlation is indicated by a plus sign (+) in the intersecting columns of two technical solutions under consideration. Negative correlation is indicated by a minus sign (–). If there is no correlation between technical solutions, their intersection cell remains empty.

In practice, when analyzing the type of correlation between technical solutions, the working team asks itself the question: «*Does improvement of this technical solution lead to improvement of any other solution either to deterioration of some other solution?*«. If neither improvement nor deterioration is indicated, there is obviously no correlation between them.

Let's take a look at the specific example of Russian Railways holding company mentioned above. The QFD working team will try to determine: «*Does the recommended technical solution to introduce Focus AS support or hinder implementation of another solution on long-term system of the holding company's interaction with key shippers?*» Both of these technical solutions can respectively facilitate implementation of the other solution, therefore, there will be a supporting correlation between them. This study is repeated for all remaining correlation cells.

For HOQ with nine technical solutions, as in our example in Pic. 4, there are 36 possible correlations. However, the larger is the composition of the matrix of technical solutions, the greater is complexity, and more details should be provided to fill in HOQ matrices. The results obtained while filling in the correlation matrix can facilitate work in complex analytical situations, ensuring that all important influencing factors have been carefully considered and evaluated. This will ensure the greatest likelihood that the improved transportation service that will be offered by the company will bring it success and will get complete satisfaction from customers.

Matrix 6: «Design tasks»

If the needs of the cargo owner describe what he needs, and technical solutions say what actions the transport company intends to take to meet his needs, then the design tasks indicate what actions to improve quality on the part of the company should ultimately be implemented and in what quantity.

For example, in our case, the customer of the company's transportation services stipulated that he wanted transportation services to be permanently available to him. The developed solutions indicate that to satisfy that need the transport company should either create a long-term system of interaction with key shippers, or reengineer the system of commercial dispatchers (let us assume that those two options have been previously assessed as most effective ways to meet the needs). Now we need to determine in the design tasks matrix how significant this solution is as compared to other solutions, and which target result should be set. This will be determined by the data that have already been calculated and entered in the previous matrices, as well as, if necessary, by the data of comparative analysis and testing. This matrix can develop conclusions derived from QFD technology and to transform them into future transportation service specifications.

The design tasks matrix consists of three sections:

• technical priorities according to the known HOQ data);

• technical comparative analysis (made based on the data collected from external sources);

• calculated target values (developed based on the results obtained while processing data of two sections above).

To determine the relative importance or priorities of each of the stated technical solutions to meet customer needs, the working team simply multiplies each of the obtained degrees of correlation of the technical solution (0, 1, 3, or 9) from interrelation matrix by the value of the total weight of the corresponding customer need from planning matrix. Then the results are summarized for each technical solution.

Referring again to the example of a conditional transport company and examining this process at the example of the technical solution of Russian Railways holding company on implementation of the Focus AS, it might be found that its interrelationship with the customer need «Timely delivery of goods» was noted in the interrelation matrix by 3 points. The value of that need in the column «Total weight» of planning matrix is marked by 6,6 points. Multiplying those two figures gives us a value of 19,8.

There might be five more correlation values for the technical solution on implementation of the Focus AS, therefore it is necessary to make six products and then to summarize them:

• For «Safety of transported cargo» it is necessary to multiply 3 by 2,4 that is 3 • 2,4 = 7,2.

• For «Regularity and rhythm»: 3 • 7,0 = 21,0.

• For «Door-to-door cargo transportation»: 3 • 7,7 = 23,1.

• For «Level of development of information systems»: 9 • 3,6 = 32,4.

• For «Full provision with documents»: 3 • 3,2 = 9,6.

In total, the technical solution on implementation of Focus AS has a priority of 113,1.

The value 113,1 is entered in the line «Technical priorities» of the design tasks matrix under the column «Implementation of the centralized system AS «Focus», as shown in Pic. 4.

A line of technical priorities is filled following the similar process for the rest of the technical requirements. The obtained values of technical priorities are absolute ones. To bring the values of technical priorities into a percentage form, it is necessary to divide the absolute values of technical priorities obtained by the total amount of all values of technical priorities and then to multiply by 100.

Percentage of the total priority = (Certain technical priority/Sum of all technical priorities) • 100. (4)

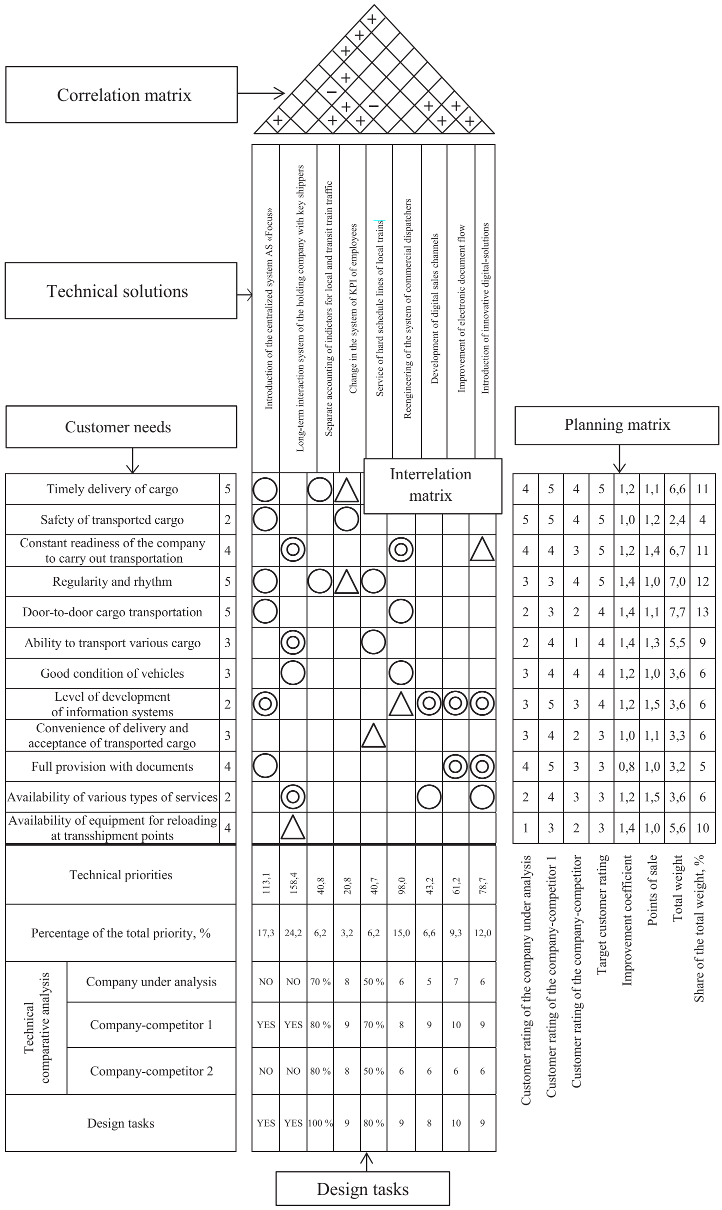
For example, for our example of the technical solution on Focus AS the calculation will look as follows:

Percentage of the total priority = [113,1/(113,1 + 158,4 + 40,8 + 20,8 + 40,7 + 98,0 + 43,2 + 61,2 + 78,7)] • 100 = (113,1 + 654,9) • 100 = 17,3 %.

Percentages for all other technical solutions are calculated and placed in the next row after technical priorities. With the exception for small round-off errors, the sum of this line should be 100 %.

Calculations showed that the technical solution on long-term system of interaction between the holding company and key shippers has the maximum percentage of total priorities (24,2 %). This suggests that to meet the needs of customers, development of a long-term system for the holding company's interaction with key shippers is by far the most important technical solution. The fact that this technical solution has a much higher percentage of overall priorities than others seems reasonable, since it affects to some extent satisfaction of five consumer needs. This information is used by a transport company as a guide for proper distribution of its own limited resources for implementation of quality improvement measures.

The next section of the design tasks matrix compares the transportation service of the transport company under analysis with



Pic. 4. Fully compiled HOQ of a transport company.

competing transportation services. Using matrix No. 3 of HOQ, the working team identified technical solutions providing for how the transport company plans to meet customer needs. The section «Technical comparative analysis» is intended to provide specific information about the competitive position of the company's transportation service in comparison with competing services of the same type for each of the technical solutions. The information for competing services can be received from customers, focus groups, media, results of quality control in the workplace, etc. Usually this is a squeeze from the aggregate of the collected information from all possible sources. The working team starts with collecting data on its own transportation service for each of the technical solutions. Evaluation data of transportation services for the own and competing companies are entered in three lines of the section «Technical comparative analysis».

The last section of the design tasks matrix allows to set specific tasks for implementation of each of the technical solutions by the working team of the company. This section shows the summary of HOQ compilation, indicates the target values and guidelines that a working team should follow in order to successfully and efficiently improve quality of transportation services.

Upon completion of the design tasks matrix, development of the House of Quality is completed. Ready to use HOQ is often used by the staff of all the departments of the transport company to focus the attention of the employees on the process of improving quality and efficiency of the work process. HOQ ensures that all the aspects of technical solutions fully comply with consumer needs without unnecessary costs and actions for the company.

Conclusion. The research allowed us to reveal the prospects of applying the approaches developed within the framework of HOQ model for analysis and assessment of quality of rail transportation services provided to cargo owners.

The promising outlook for this model is explained by the fact that any transport company has the opportunity, based on its own development, using the algorithm described in the article and considering its particularities, to conduct a multivariate analysis of its activities in the field of quality management, to evaluate effectiveness and to prioritize decisions made to improve quality of transportation services.

Meanwhile, it is necessary to implement the model's elements described in the article is a systemic way, since only observing established sequence of construction of the model and considering totality of the data collected for each matrix will ensure maximum accuracy and reliability of the results for corporate developer.

The model can be adapted by companies in other industries, considering any specifics of activity that could be described based on the described matrix.

In practice, a company can also develop HOQ, focusing on attaining its own goals of improving quality at the macro level (increasing competitiveness of the enterprise) and at the micro level (improving competitiveness of an individual product or a service). Moreover, corporate HOQ developed at the macro level will be a starting point for development of HOQ at the micro level. Thus, it is important to understand that the considered QFD methodology can be suitable for both tangible products and services.

REFERENCES

1. Anil, A. P., Satish, K. P. Enhancing customer satisfaction through total quality management practices – an empirical examination. *Total Quality Management and Business Excellence*, 2019, Vol. 30 (13–14), pp. 1528–1548. DOI: 10.1080/14783363.2017.1378572.

2. Goetsch, D. L., Davis, S. Quality Management for Organizational Excellence: Introduction to Total Quality. 7th Edition. Pearson New International Edition, 2014, 468 p. [Electronic resource]: http://en.bookfi.net/book/2267858. Last accessed 21.11.2019.

3. Dahlgaard, J. J., Reyes, L., Chen Chi Kuang, Dahlgaard-Park, S. M. Evolution and future of total quality management: management control and organisational learning. *Total Quality Management and Business Excellence*, 2019, Vol. 30 (sup 1), pp. S1–S16. DOI: 10.1080/14783363.2019.1665776.

4. Hoshin Kanri. Policy Deployment for Successful TQM. Ed. by Yoji Akao. 1st Edition. Taylor & Francis Limited, 2017, 244 p. [Electronic resource]: https://www.routledge.com/Hoshin-Kanri-Policy-Deployment-for-Successful-TQM/Akao/p/book/9781563273117. Last accessed 21.11.2019.

5. Khodyrevskaya, S. V., Gnezdilova, N. Yu. Application of House of Quality concept to improve quality of services [*Primenenie kontseptsii «Dom kachestva» dlya uluchsheniya kachestva uslug*]. *Metody menedzhmenta kachestva*, 2009, Iss. 12, pp. 48–50.

6. Anil, A. P., Satish, K. P. TQM practices and its performance effects – an integrated model. *International Journal of Quality and Reliability Management*, 2019, Vol. 36 (8), pp. 1318–1344. DOI: 10.1108/IJQRM-10-2018-0266.

7. Kiran, D. R. Total Quality Management: Key Concepts and Case Studies, BSP Books Pvt. Ltd., India, 2017, 545 p.

8. Klochkov, Yu. S. Development of the model of construction of the House of Quality [*Razvitie modeli postroeniya «Doma kachestva»*]. *Sertifikatsiya*, 2013, Iss. 3, pp. 19–23.

9. Shilo, A. N. PRO Trends: transport infrastructure as a component of an efficient economy. Report at the transport and logistics conference «PRO // Dvizhenie. Yug», July 04, 2019 [*PRO Trendy: transportnaya infrastruktura kak sostavlyayushchaya effektivnoi ekonomiki. Doklad na transportno-logisticheskoi konferentsii «PRO//Dvizhenie. Yug». – 04 iyulya 2019*]. [Electronic resource]: http://railwayforum.ru/forum-south/o-meropriyatii/prezentatsii. Last accessed 21.11.2019.

10. Sokolov, Yu. I., Efimova, O. V., Lavrov, I. M. The economic rationale for creating an integrated information space for interaction of transport companies and customers: Monograph [*Ekonomicheskoe obosnovanie sozdaniya integrirovannogo informatsionnogo prostranstva vzaimodeistviya transportnykh kompanii i klientov: Monografiya*]. Moscow, RUT (MIIT) publ., 2019, 100 p.

11. Sokolov, Yu. I. Comprehension of the Quality of production: some Contradictions in approaches. *World of Transport and Transportation*, 2004, Vol. 2, Iss. 1, pp. 72–75.

12. Sokolov, Yu. I., Shlein, V. A. Quality of Services and Components of Efficiency. *World of Transport and Transportation*, 2010, Vol. 8, Iss. 2, pp. 82–85.

13. Tasleem, M., Khan, N., Nisar, A. Impact of technology management on corporate sustainability performance: The mediating role of TQM. *International Journal of Quality and Reliability Management*, 2019, No. 36 (9), pp. 1574–1599. DOI: 10.1108/IJQRM-01=2018-0017.