

Application of the QFD method for improving railway transport services

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Abstract – Quality is the key to increasing passenger transport by rail and also to the business success of the railway undertaking itself, because the market, whether domestic or international, is conquered with a sufficiently high quality of service and not just a low cost of service. This paper defines the problem of improving the rail passenger service in accordance with customer requirements, and for this purpose, the QFD method was used as a tool for improving the service.

Keywords – QFD, quality, passenger transport, railway undertaking.

I. INTRODUCTION

The importance of the presence of railway transport companies for the carriage of passengers in a competitive race in a liberalized rail market imposes the need to constantly increase the quality of transport services. Every business, including rail companies, depends on their customers. Companies need to understand the current and future needs of their customers, meet their requirements and strive to exceed their expectations. Thus, there is no increase in the share of rail services in the liberalized rail market without an increase in the quality parameters.

Quality is the key to increasing passenger transport by rail and also to the business success of the railway company itself, as the market, whether domestic or international, is conquered with a sufficiently high quality and not just a low cost of service. To obtain such a level of service in passenger transport by rail that will meet high standards in the liberalized railway market, it is necessary to achieve a high degree of innovation with the inevitable reduction of operating costs. On the other hand, customers dissatisfied with the quality of railway services rapidly share their disappointment with other users and simply pass it on to them.

The basic measures of quality of transport service can be defined through the following requirements such as safety, reliability, regularity, speed of service, convenience of the timetable, comfort in the station and on the train, compatibility with other related transports, staff kindness, hygiene, level of information, personal and property security, catering services, complaints and more.

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This paper defines the problem of improving rail passenger service under customer requirements and introduces the QFD method as a tool to improve the service. Proper implementation of the QFD method helps the railway company to listen to the voice of the user. Therefore, the railway company can design new services more efficiently as well as improve existing ones.

II. QUALITY OF SERVICE IN TRANSPORT OF PASSENGERS BY RAIL

Transport of passengers by rail in itself is a service provided by a railway company to its users and can be described as a service having the following characteristics:

Intangibility - Passengers only have a ticket and promises that they and their luggage will arrive safely and on time to a certain place.

Inseparability - Passengers using transport cannot be separated from the means of transport by rail without using services.

Variability - Quality depends directly on the level of sophistication of the railway company, not only its technical equipment (new trains, additional services) but also the determination, knowledge and complete commitment to ensuring the quality of service that meets all passenger requirements and needs.

Brevity - means that transport on certain routes can be used at a specific time and place and it cannot be kept for later.

Railway transport services can not contain certain characteristics of tangible and intangible elements.

The inability to accommodate all activities and events in a particular urban area, as well as going to these activities in parallel with the growth of cities, creates an increased need for travel between places of residence, work, schooling, supply, recreation, treatment and other activities.

The problem arises when there is a mismatch between transportation costs and transportation options. In order to solve this problem, it is necessary to know the parameters that cause the need for travel. These parameters are called independent variables such as [7]: number of family members, family structure, social habits, origin, number of employees, income and ownership of a motor vehicle. It should be noted that the number of trips varies during the day, by months and seasons. Studies show that the main reasons for traveling are returning home and taking up about half of all trips, respectively [7]: going to work from 12% - 18%, going to school from 10% - 11%, going shopping and supplying 10% -12%, and going to recreation and entertainment from 7% - 9%.

Obviously, daily commitments such as work and school take up about 30% of all daily trips, which is a stable number of travelers, but these trips are concentrated at certain times during

the day, which impedes the organization of traffic. The most important travel parameters are [7]:

Reason for travel – it has been found that there is a relationship between travel mode and reason. Travel related to work is mostly public, while private travel is about individual transport.

The length of the trip is correlated with the choice of means of transport, such as: Short trips - non-motorized and sometimes a car; Medium-distance travel - public transport; Long distance travel - depends on the length, comfort and cost of alternative modes. Passenger parameters are related to the socio-economic characteristics of families: number of members, age, income, ownership of the vehicle, etc.

The parameters of the transport system are: time and cost of travel, and accessibility index.

According to the motive, travel can be: official, for the purpose of education, supply and sale, for health reasons, weekends and tourist trips, excursions and holidays. Based on the purpose of the journey, it is necessary to assess the needs of the passengers and the ability of the railway to fulfill the requirements and wishes, that is, to provide trains for use by the passengers through the organization of passenger traffic.

Which means of transport will passengers choose in today's market economy depends on the action of several competition factors. The factors that influence the choice of means of transport and thus the greater competitiveness are: transportation costs, speed of transport, comfort of travel and accuracy of traffic.

Transport costs in terms of competition in transport play a key role in deciding when the other terms offered are approximately equal.

Transport speed is a very important parameter of service quality. Railways invest a lot in their capacities (technical, technological and human) in order to increase the speed of transport. Facts show that on certain routes in Europe, trains run at speeds greater than 300 km/h. This led to the renaissance of the railway. Studies show that rail is faster than air at speeds of 200 km/h on distances up to 500 km, and for speeds of 300 km/h on distances up to 1000 km.

Travel comfort is very important for travelers of a higher standard, especially for official and business trips. When choosing means of transport, the passenger chooses one that offers more comfort at about the same price. Passenger comfort is ensured by the proper composition of the train, the equipment and tidiness of the railway car, the staff of the train and the large range of services.

Travel safety is a basic determinant of users in the process of choosing transport means. In terms of the number of passengers transported and the number of injured and killed passengers, rail can be considered as the safest carrier.

Regularity of traffic is one of the reasons for the reorientation of passengers to other modes of transport, and above all to the railway and this factor often plays a crucial role in the choice of means of transport.

The concept of quality is very complex and is basically a measure of meeting the needs of individuals and society as a whole. According to many authors, the qualitative indicators of railway traffic can be used to analyze the level of quality of services in rail transport and are calculated through:

- capacity - capacity can be viewed from two aspects: vehicle capacity and infrastructure,
- speed - this feature of traffic is a direct indicator of the quality of services. According to many studies, speed is always in the first three indicators of the quality of transport services for the user,
- reliability - system reliability makes the complex rail system one of the most reliable modes of transport (with air traffic),
- comfort - many travelers equate comfort with quality, which is not enough to determine quality,
- safety - the quality of services depends on safety and the need for safety meets the current needs after food, water, air (the second level in the Maslow needs hierarchy),
- efficiency - system efficiency is related to many factors such as: modern technical means, good organizational structure, good control, good infrastructure and adequately educated human resources to improve the rail passenger transport system. When all these factors come together, system efficiency is inevitable, and thus cost-effective.

In the context of this division, according to Cicak and Veskovc, the quality of services in rail passenger traffic can be seen from the following indicators:

- Transportation time (total travel time) or travel speed,
- Reliability in maintaining the timetable (regularity and accuracy),
- Frequency of departures (number of trains per route),
- Transport safety and security (level of security systems introduced, number of emergencies in relation to transported passengers ...),
- Comfort in trains and stations (places in trains, waiting rooms ...),
- Availability of stations and stops (public transport to the station, connectivity to roads, accessibility to the center of populated place ...),
- Coordination with other types of traffic (connection with other types of traffic, but also with the same type of traffic on different routes),
- Staff attitude to passengers (diligence, cheerfulness, confidence ...),
- Assortment of additional services in stations and trains (food and drink, internet ...) and
- Information about what travelers might be interested in (information before the trip, while traveling ...).

The above indicators were used for the survey of the customer's voice and the development of the QFD model.

All service companies should offer consistent, high quality service in relation to the competition. In line with manufacturing companies, a number of service companies have joined the revolutionary application of TQM (Total Quality Management), and this is especially related to the passenger transport companies. Many service companies have come to the conclusion that excellent quality gives differentiated superior value that leads to competitive advantage and profit. It is true that providing quality service results in high costs, but the investment is usually worthwhile because higher customer satisfaction leads to customer retention and increased passenger transportation.

III. QFD METHOD

The QFD (Quality Function Deployment) method is based on the concept of "Measure for process improvement", aiming to introduce a continuous organizational improvement. The QFD method is based on the requirements of transport service users and, as such, is used to improve the processes that provide the transport service. This systematic approach represents a necessary communication tool for understanding and meeting the needs and expectations of users, by correlating the voice of the customer with the capabilities of the service.

The purpose of this method is to identify correlations, i.e. critical processes and activities, and to introduce corrective measures to improve them. By using this method, the railway company evaluates its work and, based on the findings, improves its operations. Also, this method allows the company to compare its operation over the time as well as with other companies.

QFD method is mainly described through four stages, which are implemented within four so-called 'houses of quality' (Figure 1). 'Houses of quality' represent matrices formed in a way that they have the same basic look in every stage (Masing 1988). 'House of quality' consists of six major steps (Chan, Wu 1998; Wuet al. 2005; Wu 2006; Shieh, Wu 2009): customer requirements (WHATs), planning matrix, technical measures (HOWs), relationship matrix between WHATs and HOWs, technical correlation matrix and technical matrix. At the entrance to the 'house of quality', in the left column, there is always a question: 'What is required?' and at the exit, there is always the answer: 'How to comply with requests?' QFD presents system service planning process, which starts with the Stage I where users' wishes, needs and expectations are defined based on the research results.

Afterwards, within Stage II, critical service components, which require more detailed research are defined. Stage III comprises defining of production process critical parameters i.e. service providing, and finally, in Stage IV, service quality control processes, i.e. instructions and measures to be taken for implementation of the process itself with certainty, are defined. Users' attitudes are the basis for defining the most important service features, which have the biggest effect on the level of quality of service offered to users. Therefore, for further research analysis, the most critical part of the process is Stage I. Results of this stage represent key users' requests and their importance as well as key service features essential for required quality production. This lead to users' satisfaction and market advantages achievement.

The procedure of Stage I within defining research methodology was implemented through the completion of the first 'house of quality' (Figure 1).

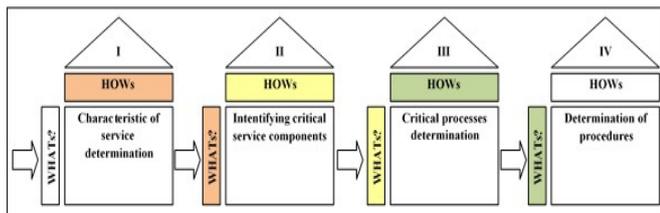


Figure 1. Stages of QFD method (method implementation on service)

IV. APPLICATION OF THE QFD METHOD IN TRANSPORT OF PASSENGERS BY RAIL

Railway companies that use market analysis generally apply several research methods which often do not require the involvement of experienced or trained researchers but are conducted by full-time employees through pre-structured questionnaires, books of complaints and compliments, etc. They also conduct measurements of fixed-term passenger flow for analyzes according to different operational needs. Very often, surveys are conducted during the planning of a timetable that considers the desired departure and arrival times for passenger trains.

To investigate the quality of service in the transportation of passengers by rail for the purposes of this work, a survey of users of the railway service Serbia Train was conducted. Data were collected through a questionnaire. The aim of the questionnaire was to collect user views, i.e. their expectations that the rail service should meet. The group of 185 subjects were interviewed (46% students, 6% pupils, 27% employed, 13% unemployed and 8% others). The group consisted of 68% male and 32% female subjects.

There are several software for QFD method. Quality Function Deployment Versao 1.1 – Free, was used in this work. Figure 2 shows the layout of the software used [9].

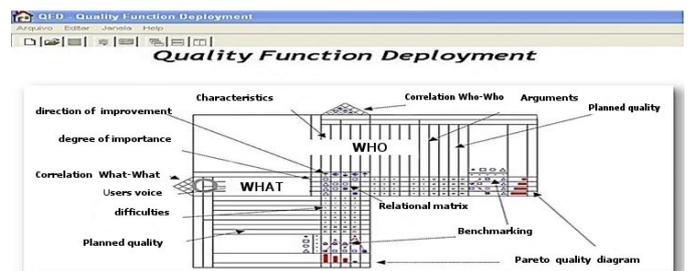


Figure 2. Layout of the QFD software package used in this work

The user requirements were quantified respectively from 1 to 10, where they were assigned absolute and relative ratings, i.e. significance. Significance was obtained by grading from 1 to 5, where 1 means less and 5 means greater significance. Through this process, a number of significant factors were formed. The assessment of the interdependence of all combinations of user requirements is indicated by: (Δ) \rightarrow small dependency \rightarrow (1), (O) \rightarrow medium dependency \rightarrow (3) and (\odot) \rightarrow large dependency \rightarrow (9). The coefficient of significance of the qualities from the point of view of satisfaction of the user demands, i.e. the correlation is shown by the labels: (++) \rightarrow very positive correlation, (+) \rightarrow positive correlation, (-) \rightarrow negative correlation, (--) \rightarrow very negative correlation, and, if there is no correlation, an empty field was left. Only technical characteristics can have measurable goals. Unmeasurable quality elements were discarded.

In the last step, data were entered for some of the direct competitors to rail passenger transport, after which the significance of service quality was assessed in relation to customer demands, on a scale from 1 to 5, with demand rated 1 having less and 5 higher significance. Using the QFD 1.1 program, entering the "WHAT" requirement begins the

construction of the first "quality house" whose final layout is presented in Figure 3.

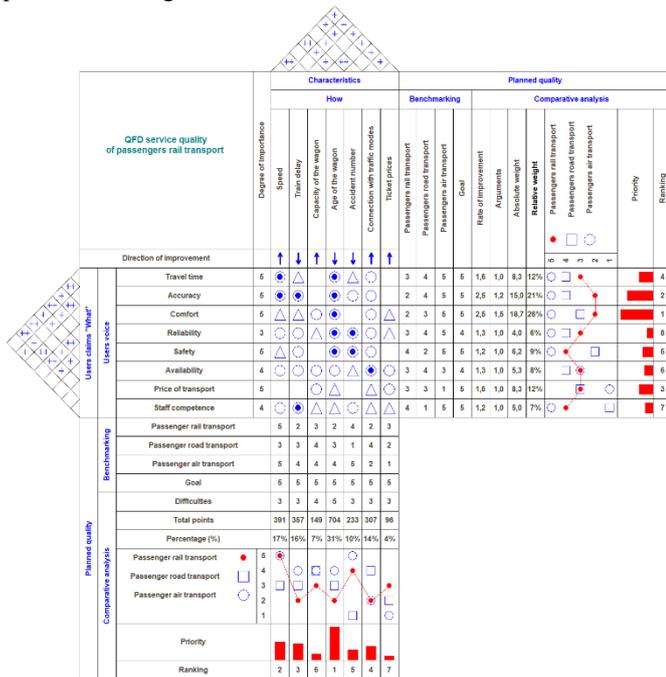


Figure 3. Application of the first quality house

Analyzing the results of the first "quality house", it can be seen that there is not a single "WHAT" requirement that does not have the answer "HOW", which is a prerequisite for the construction of "quality house". Likewise, the roof of the "quality house" or the "HOW-HOW" correlation indicates that there are no "HOW" answers that contradict each other, or the execution of one would impede the execution of the other. On the basis of the relative weights obtained from the Pareto diagram of the request "WHAT", the order of the characteristics crucial for ensuring adequate quality of service was defined. In the first three places are the following features: comfort (21%), reliability (21) and safety (15%). The Pareto Diagram of the answer "HOW" gave priorities that need to be improved in order to increase the quality of service in passenger transport of Serbia trains. In the first three places are the following features: train delay (38%), car age (30%) and car capacity (21%).

V. CONCLUSION

The level of rail passenger transport services in Serbia is quite modest in its content. The main reason for this is the fact that very little is invested and that insufficient attention is paid to the development of the railway network and trains. Many trains are at the very limit of their depreciation life. Rail transport has a future and this is confirmed by the current strategies of the EU and its relevant institutions. Rail transport is a much more environmentally friendly mode of transport because it can use renewable energy and can be a fully automated system. However, the path to taking a leading role in passenger transport is quite long, and a higher level of service quality than competing modes of transport must be ensured. The main features required for a good image of the service quality are the convenience of rail transport, security,

additional services, etc. The QFD method applied to analyze the quality of rail passenger services has shown that the quality of services is influenced by many factors. The survey compared the perceptions and expectations of the service received by the customers. Comparison of user requirements and service quality yielded relative weights of features. Based on the obtained relative weights, the features crucial for ensuring adequate quality of service were ordered by their importance.

The sequence of identified features indicates that these features are critical to ensuring the satisfactory quality of rail passenger service. By using a comparative analysis of our performance and those of competitors, it can be concluded that the quality of rail passenger transport service is not adjusted to the needs and expectations of users. Based on these results, it can also be concluded that the QFD method is a useful method for developing and improving the quality of rail passenger services. The QFD method can help railway companies to improve the quality of their services by linking them with customer requirements, ensuring their competitive advantage in the market.

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