**Automation of the procedure for assessing the quality of transport service for the population in the conditions of digitalization of the railway transportation system**

T A Bulokhova\(^1\), V A Olentsevich\(^1\), V Yu Konyukhov\(^2\) and D A Lysenko\(^2\)

\(^1\) Irkutsk State Transport University, 15, Chernyshevskogo str., Irkutsk, 664074, Russia
\(^2\) Irkutsk National Research Technical University, 83, Lermontova str., Irkutsk, 664074, Russia

E-mail: bulokhova@irgups.ru

**Abstract.** The Strategic Program for the Development of Railway Transport until 2030 focuses on the development of a customer-oriented approach as one of the conditions for the company's competitiveness. The customer focus is one of the elements of anti-crisis management of transport systems, it provides additional opportunities, especially when the volume of traffic decreases, when it is necessary to fight for attracting customers. A customer-oriented approach is closely related to the quality of the organization of transport services for passengers, which is certainly impossible without the use of modern automated technologies. Thus, a modern passenger is characterized by mobility and the habit of being online, in connection with which the passenger infrastructure and rolling stock must be provided with equipment and software that allows the passenger to remain in the familiar information environment.

1. **Introduction**

The implementation of a customer-oriented approach is possible only under the condition of well-functioning feedback channels, through which they receive an objective and relevant assessment of the quality of services from the passenger. For this purpose, the customer service sector and the marketing group of the Federal Passenger Company regularly analyze the quality of passenger service. The assessment of the quality of the organization of transport services for passengers carried out by the authors revealed a number of problems in this area. So, in marketing research, the assessment is carried out according to six criteria, and the employees of the client services sector, the assessment is carried out according to four, which violates the comparability of the data, in addition, the periods of the assessment do not coincide.

To eliminate the identified shortcomings, the authors proposed an automated procedure for assessing the quality of the organization of transport services for passengers, carried out using the correlation analysis of the pairwise dependence of the indicators of marketing research and the implementation of the parameters of client services. The use of correlation analysis will make it possible to determine the degree of dependence between the estimated indicators in order to further their automated selection and establish a single list of criteria for joint analysis of the quality of transport services [1, 2].

The activity of the railway transport system (RTS) in Russia deserves special attention when creating optimal economic conditions for the development of regions, for modernizing the entire transport sector of the country, during the transition to innovations and ensuring a stable growth of the national economy.
It contributes to creating conditions for ensuring Russia's leadership in the world transport system. In recent years, the holding company Russian Railways has chosen the vector of a customer-oriented approach, which provides additional opportunities in the face of competition in the transport market for a client and a reduction in passenger traffic.

The very model of a customer-centered approach also includes systems that influence the quality of services provided to passengers at stations and on trains. The modern passenger is characterized by mobility and the habit of being online, in connection with which the passenger infrastructure and rolling stock must be provided with equipment and software that allow the passenger to remain in the familiar information environment [3-5].

In the industry, there is an acute problem of increasing the competitiveness of transport systems, including by improving the quality of transport services for the population [6, 7]. It is also important that for the development of the railway passenger complex, there is no need to invent anything superfluous, you just need to modernize services for real time and demand. Modern passenger complexes should be not only a place for serving passengers, but also a territory to attract the urban population.

2. The main tasks of digitalization of the transport system in the field of passenger transportation

The key principle of customer focus is “How a customer orients a company can only be decided by the customer - and never the company manager”. The implementation of this principle in the railway transport system is possible only if there are "feedback" channels through which the client transmits an objective assessment of the quality of the services provided, using, for example, a system of questionnaires and surveys, IT technologies and Internet resources, Figure 1.

Currently, in all structural divisions of the railway transport network, a lot of work is underway to create a client-oriented system for the implementation of services based on:

- creation of unified call-centers, services rendered on the principle of "one window";
- provision of constant "feedback" with passengers;
- development of approaches to the formation of a competitive system of tariff setting for services not regulated by the state;
- formation of marketing and service promotion centers;
- development of the institution of managers for work with clients;
- active promotion of the services of the Russian Railways holding on the Internet;
- development of industry standards for interaction with customers, etc.

![Figure 1. The Statistics of incoming requests from service consumers’ passenger complex.](image)
Over the past eight years (from 2010 to 2018), the number of long-distance passengers transported decreased by 4.3%; the passenger turnover during the period under review decreased by 13.3%. One of the reasons for the reduction in passenger traffic and long-distance passenger traffic is associated with the development of competition with other modes of transport. Therefore, for comparison, over the same period, the passenger turnover in air transport, including international traffic, almost doubled: from 147.1 billion pass-km to 286.3 billion pass-km.

The innovative development of railway transport presupposes not only an increase in the volume of transportation of goods and passengers, but also an improvement in the quality of service provision, ensuring a high level of competitiveness of the industry, due to the digitalization of the railway transport system as a whole [3, 8, 9].

3. Organization and problems of assessing the quality of passenger service

The quality of transport services is understood as the ability of the transport system to satisfy the need for travel, as well as the associated needs, subject to the following conditions must be met [9-11]:

- transport accessibility - everyone who wants to travel can do it;
- customer satisfaction - consumers perceive the services of the transport system positively; they are satisfied with the level of comfort, they do not experience the negative effects of the external environment associated with receiving transport services, etc.);
- compliance with technology - the transport system is fault-tolerant, technologically and economically efficient, safe, the level of rejects does not exceed technologically sound limits.

Assessment of the quality of transport services is carried out according to certain criteria, which are enshrined in a number of regulatory documents [10, 12]. When assessing the quality, it is recommended to single out the following indicators of the quality of transport services for passengers (KTOP) [10, 13]: availability, efficiency, reliability, convenience.

The Federal Passenger Company (hereinafter OJSC FPK) has adopted a two-tier approach to quality assessment. Marketers assess the "perceived" quality of services, the customer service sector - the "provided quality of service" using a questionnaire consisting of 90 questions, with a frequency of once a quarter [10, 14, 15]. The Customer Services Sector conducts a monthly audit evaluating two hundred and fifty questions. Table 1 shows the estimated indicators by areas of responsibility.

| Marketing research | Customer service sector | Area of responsibility |
|--------------------|-------------------------|------------------------|
| Evaluation of the ticket purchase procedure | Evaluation of fulfillment of requirements for cash services and railway agencies | East Siberian Railway Agency |
| Assessment of the conductor's work | Service assessment en route | Department of passenger service and provision of services on trains |
| Ride comfort assessment | | East - Siberian branch |
| Assessment of the technical condition of the car fleet | Assessment of the technical condition of cars | Department of repair and operation of passenger cars |
| Evaluation of catering services provided on trains | Evaluation of food services en route | Food service sector |
| Evaluation of the convenience of the schedule, the duration of the trip and the ability to travel in the desired direction | | Department of planning and organization of transportation of passengers, baggage and cargo |

It can be seen from the presented table that the assessment of the comfort of the trip and the assessment of the convenience of the schedule fall out of the zone of consideration by the employees of the client services sector. Therefore, these indicators are not analyzed. In addition, the assessment of
other "joint" indicators is carried out by researchers using different methods. Marketers, as mentioned above, are guided by a survey of passengers, and the customer service sector is based on personal checks. In this regard, there are often conflicting data on the estimated indicators.

4. Automation of the methodology for researching the quality of passenger service

To solve this problem, the authors propose to conduct a study of the pairwise relationship between the indicators for assessing the quality of services provided by the marketing department and the customer service control department using correlation analysis. The purpose of correlation analysis is to identify an estimate of the strength of the relationship between random variables (features) that characterize some real process. Carrying out this kind of research will allow measuring the degree of closeness and coherence of quality assessment indicators obtained during the study by different structural divisions, as well as establish a single list of criteria for joint analysis of the quality of transport services using an automated assessment system [5, 16, 17].

In addition, it is proposed to use GAP-analysis to compare the current indicators of quality assessment with the target, in order to develop adequate corrective measures to achieve the target state in the field of quality [10, 18, 19].

The essence of the method is to study the problem, which manifests itself as a gap arising in the course of the implementation of the change plan, between the indicators and results, the achievement of which was planned and what happened in reality (Figure 2).

When carrying out the correlation analysis, the authors used data on four areas of responsibility:
- cash services;
- on serving passengers along the route;
- on the technical condition of the cars;
- on the provision of food services along the route.

The automated procedure for analyzing the current state of the "perceived" and "supplied" quality of services at JSC FPC is based on a study of the change in time (dynamics) of the average score (B̅). It is based on the results of marketing research and changes in time (dynamics) of the average percentage (P̅) fulfillment of the controlled quality parameters for a certain period of time from 2015 to 2018 [4, 10, 20]. The implementation of the project will allow forming new principles and models of work of structural units of the railway passenger complex in the conditions of widespread penetration of automated technologies, making it possible to transfer the organization and operation technology to a qualitatively new level, optimize operational work and improving the quality of service for service users.
The article presents an algorithm for automating the procedure for conducting a joint analysis of the "perceived" and "provided" quality of services to passengers, Figure 3.

**Figure 3.** Algorithm for automating the procedure for conducting a joint analysis of the "perceived" and "provided" quality of services to passengers.

The dynamics of the average score of marketing research indicators is presented in table 2.
Table 2. Dynamics of the average score of marketing research indicators.

| No | Areas of responsibility                  | 2011  | 2012  | 2013  | 2014  |
|----|-----------------------------------------|-------|-------|-------|-------|
| 1  | Cash service                            | 4.40  | 4.60  | 4.45  | 4.65  |
| 2  | Service of passengers along the route    | 4.25  | 4.50  | 4.40  | 4.65  |
| 3  | Technical condition of wagons           | 4.40  | 4.54  | 4.59  | 4.70  |
| 4  | Providing food services along the route  | 4.13  | 4.22  | 4.25  | 4.65  |
| 5  | Average score based on marketing research| 4.30  | 4.46  | 4.42  | 4.66  |

Table 3 shows the average percentage of completion of grouped statistics of monitored parameters by the customer services sector over four years.

Table 3. Summary of performance of parameters of client services on average, %.

| General controlled parameters                        | 2011 | 2012 | 2013 | 2014 |
|------------------------------------------------------|------|------|------|------|
| Cash service (average)                               | 80   | 81   | 88   | 90   |
| Technical condition (average)                        | 87   | 93   | 94   | 96   |
| Passenger service (average)                          | 91   | 92   | 94   | 94   |
| Organization of meals along the route (average)       | 81   | 82   | 82   | 87   |
| Average percentage of parameter completion           | 88   | 90   | 92   | 93   |

The data for carrying out the correlation analysis for the East Siberian branch of JSC FPK as a whole for each area of responsibility for all the periods assessed are presented in Table 4.

Table 4. Correlation analysis data.

| Name of the responsible subdivision of the East Siberian branch of JSC "FPK" | 2011 | 2012 | 2013 | 2014 |
|-------------------------------------------------------------------------------|------|------|------|------|
| Cash service (Railway agency)                                                | 4.4  | 80   | 4.6  | 81   | 4.45 | 88   | 4.65 | 90   |
| Passenger service en route (Passenger Service Department)                    | 4.25 | 87   | 4.5  | 93   | 4.4  | 94   | 4.65 | 96   |
| Technical condition of cars (Department of repair and operation)             | 4.4  | 91   | 4.54 | 92   | 4.59 | 94   | 4.7  | 94   |
| Providing food services in transit (Food Sector)                             | 4.13 | 81   | 4.22 | 82   | 4.25 | 82   | 4.65 | 87   |

B - level of perceived quality of services, score; P - service quality level, %

Let us build a correlation between the parameters and conduct a gap analysis between the indicators. The calculated data on the correlation coefficient are presented in Table 5.

Table 5. Calculated data on the correlation coefficient.

| Indicators                        | Correlation coefficient |
|-----------------------------------|-------------------------|
| Cash service                      | 0.406                   |
| Technical condition               | 0.894                   |
| Passenger service                 | 0.906                   |
| Catering on the go                | 0.997                   |

As you can see from the table 5, according to the indicator "Cash services", the correlation coefficient was 0.4. This value indicates the absence of correlation factors. The reasons are that there are discrepancies in the obtained data for marketing research and the customer services sector, as well as different monitoring periods. In order to eliminate this problem, it is necessary to analyze the reasons
for the lack of correlation, as well as develop and implement a single list of quality parameters monitored and evaluated in the questionnaires.

The correlation dependence of the indicator "Technical condition of a passenger car" is shown in Figure 4.

Figure 4. Correlation dependence of the indicator "Technical condition".

As we can see from the constructed dependence of the criterion "Technical condition of the passenger car", the correlation coefficient was \( R = 0.89 \), which indicates a high dependence between the data. A "positive" correlation means that an increase in the level of fulfillment of controlled quality parameters on trains leads to an increase in the level of customer focus of the company. And, consequently, this leads to a reduction in the "gap size" between the "provided" to the passenger and the "perceived" passenger quality of services, which in turn leads to improvement of the quality of service for the population as a whole.

Correlation dependence of the indicator "Passenger service" is in Figure 5.

Figure 5. Correlation dependence of the indicator "Passenger service".
According to the constructed dependence of the criterion "Passenger Service", the correlation coefficient was $R = 0.9$, which indicates a high dependence between the data. The GAP analysis showed that the gap between “perceived” and “provided” quality of services is minimal, which also indicates a high degree of dependence between indicators.

The correlation dependence of the indicator "Organization of meals on the way" is shown in Figure 6.

![Figure 6](image)

**Figure 6.** Correlation dependence of the indicator "Organization of meals on the way".

According to the constructed dependence of the criterion "Organization of meals on the way", the correlation coefficient was $R = 0.9$, which indicates a high dependence between the data.

Below is a general correlation analysis for all indicators considered in the table (Figure 7).

![Figure 7](image)

**Figure 7.** Correlation between indicators.

The calculated value of the criterion was $R = 0.65$, which is more than the critical value. Thus, there is a relationship between the indicators.

As an example, Figure 8 shows the GAP-analysis according to the criterion "Cash services".
Figure 8. GAP-analysis of the "Cash service" parameter.

As you can see, the gap between the target (100%) indicator of the quality of passenger service and the actual values for the study period is narrowing, which indicates an improvement in the quality of service and the achievement of the target state.

5. Conclusion
Summarizing the above, the following should be noted. The railway transport network operates in conditions of fierce competition from other modes of transport. One of the ways to increase competitiveness is to increase the customer focus of the company, including through the use of modern digitalization tools. To this end, in order to conduct a more complete study of passenger service quality indicators, it is advisable to use an automated correlation analysis procedure to test the hypothesis about the statistical dependence of the values of the estimated indicators obtained from the results of marketing research and the client services sector. In the case of obtaining a correlation between the estimated indicators, it is recommended to supplement the GAP-analysis aimed at determining the degree of discrepancy between the indicators.

The use of the automated procedure presented by the authors in the study of indicators of the quality of passenger service in the railway transport system allows timely identification of discrepancies in the data obtained by the client services sector and the marketing staff. And, therefore, there is a chance to have a more realistic picture of the quality of transport services for the population. Automation of railway services in the field of passenger transportation is important for the development of customer focus of the passenger complex, since of all types of transportation are in this transport system, only a passenger can assess the quality of transportation and, depending on this, make a decision to use the services of railway or another type of transport

References
[1] 2019 Railway transport in Russia: challenges until 2025 (Institute of Natural Monopolies)
[2] 2018 Development strategy of Federal Passenger Company JSC until 2030. Reporting materials in accordance with the terms of reference
[3] Larin A N and Larina I V 2017 Customer-oriented approach in structural divisions of Russian Railways Economy of railways 11 30-37
[4] Tereshina N P, Zhakov V V and Filimonova Z V 2017 Increasing the competitiveness and quality of freight traffic Economy of railways 8 41-49
[5] Elizariev M Yu 2012 Assessment of the quality of transport services for the population Economy of railways 5 92-97
[6] Kargapoltsev S K, Gozbenko V E, Kuznetsov B O, Karlina Yu I and Karlina A I 2019 The effect
of the periodic driving force on a system with two degrees of freedom \( J. \text{ of Phys.: Conf. Ser.} \ 1333(5) 052009 \)

[7] Gozbenko V E, Kargapoltsev S K, Kuznetsov B O, Karlina A I and Karlina Yu I 2019 Determination of the principal coordinates in solving the problem of the vertical dynamics of the vehicle using the method of mathematical modeling \( J. \text{ of Phys.: Conf. Ser.} \ 1333(5) 052007 \)

[8] Kuznetsov B O, Gozbenko V E, Kargapoltsev S K, Karlina Yu I and Karlina A I 2019 Dynamic vibration protection of the railway carriage \( J. \text{ of Phys.: Conf. Ser.} \ 1333(5) 052018 \)

[9] GOST R51004-96 \( Transport \) services. \( Passenger \) Transportation. Nomenclature of quality indicators

[10] Bulokhova T A 2016 On the issue of improving the quality of transport services \( Modern \) approaches to management in transport and logistics: \( Coll. \) of mater. of the All-Russian sci. and pract. conf. (Moscow: Moscow State Transport University) p 33

[11] Yolkin K S, Yolkin D K, Kolosov A D, Ivanov N A and Shtayger M G 2018 Technologies, which allow to reduce an impact of metal silicon production on the environment \( IOP \) Conf. Ser.: Mater. Sci. Eng. \( 411 \) 012028

[12] Bulokhova T A 2020 Modeling the assessment of the quality of transport services for the population \( Modern \) technologies. \( System \) analysis. Modeling \( 65 \) 128-136

[13] Gozbenko V E, Olentsevich V A and Belogolov Yu I 2018 Automation of individual operations of the transportation process in order to ensure sufficient conditions for the optimal functioning of digital transport and logistics \( Modern \) technologies. \( System \) analysis. Modeling \( 4(60) \) 125-132

[14] Konyuhov V Yu, Gladkikh A M, Galayautdinov I I and Shchadova E I 2020 Calculations of efficiency in implementing progressive mold forming methods \( IOP \) Conf. Ser.: Mater. Sci. Eng. \( 760(1) \) 012027

[15] Gozbenko V E, Kargapoltsev S K, Karlina Yu I and Karlina A I 2019 Vibration state of technical facilities \( IOP \) Conf. Ser.: Earth Env. Sci. \( 378(1) \) 012058

[16] Suslov K, Solonina N and Gerasimov D 2018 Assessment of an impact of power supply participants on power quality \( Proc. \) of Int. Conf. on Harmonics and Quality of Power pp 1-5

[17] Ilyushin P and Suslov K 2019 Operation of automatic transfer switches in the networks with distributed generation \( IEEE \) Milan PowerTech 8810450

[18] Voropai N, Ukolova E, Gerasimov D, Suslov K, Lombardi P and Komarnicki P 2019 Simulation approach to integrated energy systems study based on energy hub concept \( IEEE \) Milan PowerTech 8810666

[19] Kolobnev N I, Ber L B, Khokhlatova L B and Ryabov D K 2012 Structure, properties and application of alloys of the Al - Mg - Si - (Cu) system \( Metal \) Sci. and Heat Treatment \( 53(9-10) \) 440-444

[20] Olentsevich V A and Gozbenko V E 2019 \( Methodological \) and software support for predicting the values of the safety level of the functioning of the railway transport system, monograph (Irkutsk)