Multimodal transport as a mechanism for increasing the competition of long-distance passenger services

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Abstract. Multimodal transportation will not only increase the intensity of use of vehicles, but also reduce the passenger's travel time. The main task of organizing multimodal transportation is to maximally satisfy the demand of the population for transport services with the most efficient use of rolling stock. For a more effective solution to this problem, it is necessary to analyze the process of planning passenger transportation, evaluate the possibilities of marketing research in this area and conduct typifying of lines from the point of view of organizing multimodal transportation. The paper describes in detail the passenger transportation planning scheme and proposes an algorithm for assessing the effectiveness of managerial decisions. To improve the efficiency of making managerial decisions in the field of destination and cancellation of passenger trains of various categories, direct trains, trailing cars, organization of multimodal transportation, it is proposed to typify the lines with dividing them into 5 categories. Thus, the solution to the problem of maintaining the share of passenger traffic can be either the development of direct railway links, or the transition to multimodal transportation with the condition of coordinating the time of transfer.

1. Introduction
Ensuring comfortable and quick moving of people by rail is one of the factors to improve the quality of life. Today's market of transport services operates in conditions of strong competition, which dictates the need for continuous development and improvement of all its participants.

Nowadays, the market for transport services cannot ignore the fact that transporting passengers over more or less long distances is not limited to one mode of transport[1]. At least before the start of a travel, railway or air, in most cases, a passenger uses the services of road transport or the metro. There exist more complex delivery schemes when it is necessary to organize a passenger transfer from one mode of transport to another at different points on its route[2]. At the same time, it is worth considering that the most quickly exhaustible and valuable resource for each person is time.

The share of passenger rail traffic in the market of our country has decreased by 2 times for last 14 years. Obviously, the creation of the foundation for accelerated development should be based on the introducing of advanced technologies, which are based on logistics and process management based, in turn, on models and clearly formalized methods. [3]

The limited passenger transportation market leads to increased competition between modes of transport on individual routes, which encourages carriers to develop new lines of business and transportation services.
At the moment, the main directions of innovation activity of "Russian Railways" JSC, associated with the development of long-distance passenger traffic, are: development of high-speed and superhigh-speed traffic, renewal of traction and non-traction rolling stock, development of multimodal transportation.

Multimodal transportation is one of the main conditions for creating efficient urban transport systems in agglomerations, as it contributes to the rational distribution of passenger flows by mode of transport[4]. This is also fair for long-distance routes, where the cooperation of modes of transport can not only increase the intensity of use of vehicles, but also shorten the passenger’s travel time[5].

The main task of organizing multimodal transportation is to maximally satisfy the demand of the population for transport services along with the most efficient use of rolling stock.

2. Research methods
To solve this problem, it is necessary first of all to formalize the process of planning passenger transportation, which consists in determining for the future the volume of transportation and the need for technical means for their development. The main criteria in choosing a rational option is indicators of the transportation quality. Information support for the planning system, implemented on the basis of ACS-L, includes data on carriage volumes, the use of cars in the passenger fleet, the structure of realized demand by train categories and types of cars, the dynamics of operational indicators for roads and directions of the network, as well as management decisions in the field of destination and cancellation of direct trains, trailed cars, an organizing of multimodal transportation[13].

To increase the competitiveness of railways in providing of passenger transportation, it is necessary to use marketing principles to activate non-price forms of competition and create sustainable consumer preferences, regardless of the tariff policy. One of the most important elements of marketing is market research. Research among passengers is carried out by personal interviewing method. Interviewing is the most common method of collecting quantitative data.

For a more effective solution to the problem of organizing multimodal transportation, the line typing can be used depending on the characteristics of the organization of passenger traffic.

As a result of the analysis of the specific features of infrastructure and operation of railway lines for making managerial decisions in the field of destination and cancellation of passenger trains of various categories, direct trains, trailers, organization of multimodal transportation, it is proposed to differentiate lines into 5 categories.

3. Research results
The process of planning passenger transportation is to determine for the future the volume of traffic and the need for technical means for their development. The main criteria in choosing a rational option is indicators of the transportation quality. Information support for the planning system, implemented on the basis of ACS-L, includes data on volumes of traffic, use of cars in the passenger fleet, structure of realized demand by train categories and types of cars, dynamics of operational indicators for roads and directions of the network, as well as the making management decisions in the field of destination and cancellation of direct trains. Planning is carried out in several stages (Figure 1).
Figure 1. Scheme of passenger transportation planning.

At the first stage, there are being determined: the paying capacity of the population, the structure of the consumer budget, and the separation of social groups of potential passengers by purchasing power [6].

At the second stage, the forecast of the expected passenger flow is made. The process of studying passenger traffic consists in identifying trends and patterns in their formation, determining periods of minimum and maximum demand, conducting a situational analysis of traffic indicators and identifying “problem” segments. The structure of passenger traffic is considered from the point of view of demand for transport services by train categories, types of cars and service classes, separately assigning trailed cars and direct train cars.

The third stage is to calculate the number of cars for the development of passenger traffic, while taking into account the seasonality of transportation and the need for a technological reserve of the fleet. The calculation of the car fleet is carried out on the basis of the indicators such as the performance of the car, uneven demand for transportation, taking into account the timing of repair of rolling stock and its maintenance [7]. The analysis is carried out on the basis of operational indicators for a number of previous years and the actual state of rolling stock. At the fourth stage, the results of train operation are monitored. The dependence of revenues on the predicted passenger flow is determined and operating costs are calculated [6]. At the final stage of planning, the need, possibility and expediency of assigning additional routes, the number of direct and local trains, train patterns, and volumes of direct wagons are determined.

Regulatory measures are carried out during the year if it is necessary to increase or decrease the carrying capacity of railway lines. At the same time, measures are timely and necessary if a balance is maintained between the demand for transportation and the number of seats offered for sale on long-distance trains. Composition patterns of long-distance trains are subject to adjustment according to the
dates of travel and are changed along the route due to the inclusion of direct and trailed groups of cars, the organization of multimodal transportation.

In order to study the passenger transportation market, both primary and secondary information should be used. Secondary information is contained in various accounting and statistical documents[8]. They are at the disposal of both railway structures and regional entities. On the one hand, secondary information is less time-consuming, and on the other hand, it may lead to distorted results and conclusions, as it was collected for other purposes[9].

Research among passengers is conducted using the technology of personal interviewing. A personal interview is conducted according to a structured questionnaire. This method allows getting answers to questions of increased complexity, as the interviewer has the opportunity to explain their interpretation more accurately[10]. During the interview, the interviewer may interest the respondent, establish the best quality contact with him, and reduce the probability of rejection of answers. The interviewer himself conducts a survey on the questionnaire, which eliminates confusion, omission of questions due to misunderstanding of their meaning. A personal interview is characterized by high flexibility; in its process, large amounts of information can be obtained. In the long-distance transportation segment, quarterly studies are carried out by subsidiary companies of the Federal Passenger Company. In contrast to the suburban complex, the rating scale is five-point.

Passengers are asked to evaluate the services related directly to transportation according to certain criteria.

The selected criteria for assessing the possibility of assigning multimodal transportation can be:

- service availability: ticket purchase procedure, availability of tickets with required parameters, the ability to buy a ticket for multi-modal transportation
- satisfaction with travel time,
- quality of passenger service in the transport hub,
- convenience of train schedules when organizing multimodal transportation,
- level of service: work of the conductor, sanitary condition of the car, food, interior, bedding and accessories, ensuring travel safety, the cost-to-quality ratio of services.

Despite the peculiarities of conducting questionnaires in structural units, the overall objective is to obtain feedback from the passenger for making management decisions on the introduction of new products or services, as well as taking corrective measures to improve the quality of service [11].

The bet on direct contact of Russian Railways representatives with a passenger through questionnaires allows them to get all the necessary data first hand. This increases the accuracy of the information collected and increases the company's capability to correctly redistribute its resources to eliminate weaknesses [12]. A detailed assessment of the data obtained during the interview and the customer satisfaction profiles built on the basis of the results obtained allow us to correctly evaluate the final results. Competent calculation of the overall assessment of passengers’ attitude makes it possible to develop the final model and determine areas of increased attention on the network.

As a result, this information becomes an important basis for improving the work of passenger companies, gives a full picture of the need for an implementing of corrective measures, as well as an introducing of new products and services.

The satisfaction rate on the point system is calculated as the sum of the average values of satisfaction by factors divided by the number of estimated factors within each criterion[9]

\[
K_u = \frac{\sum A_{av}}{n} ,
\]

wherein: \( K_u \) - satisfaction rate by criteria, in points;
\( A_{av} \) - average value of satisfaction by factor, in points;
\( n \) - number of factors within criterion, in points.

The satisfaction rate for a point system in a suburban service is calculated as the sum of the average satisfaction values for all criteria divided by the number of evaluated criteria:
\[ K_s = \sum K_{is} / n, \quad (2) \]

wherein: \( K_s \) - average satisfaction rate for all criteria for the Directorate, in points;
\( K_{is} \) - average satisfaction by criteria, in points;
\( i \) - designation of criteria A, B, C, etc.
\( n \) - total number of criteria, in points.

To calculate the percentage satisfaction rate, the following formula is used:
\[ K_{s(\%)} = \frac{K_s \times 100\%}{10}, \quad (3) \]

wherein: \( K_s (\%) \) – satisfaction rate, %;
\( K_s \) - satisfaction rate, in points;
10 - maximum number of points in the rating scale used to collect primary data.

To assess the weight and importance of a criterion:

- list of key criteria is made;
- assessment of criterion importance \( (nt) \) is determined by expert evaluations method on a 10-point scale \( (10 - strong \ impact, 1 - no \ impact) \);
- weighting factors \( (xt) \) is calculated, sum of which is equal to 1 by all criteria;
- assessment of customer satisfaction rate \( (Kt) \) is determined;
- assessment of criterion impact is determined:
\[ z_t = ntxtKt, \quad (4) \]

where \( t \) – assessment criterion.

As a result of such calculations, the most significant and important factors for the passenger’s choice to prefer rail transport are revealed.

Algorithm for assessing the effectiveness of management decisions in the field of passenger transportation is shown in Figure 2.
To increase the efficiency of managerial decision-making in the field of destination and cancellation of passenger trains of various categories, direct trains, trailed cars, organization of multimodal transportation, it is proposed to differentiate lines into 5 categories.

Lines of the 1st category – double-track lines, with high capacity, which organized the movement of high-speed, superhigh-speed, fast and long-distance passenger trains with a minimum number of stops, an average of one stop per 100 km section. Usually, these are infrastructure-developed double-track sections with a powerful passenger flow, where the movement of high-speed and long-distance passenger trains is organized, as well as intensive suburban traffic. In such areas, given the high workload and high passenger traffic, between the stations of destination and departure, high-speed and long-distance trains have a minimum number of stops along the route or do not have them at all. The

**Figure 2.** Algorithm for assessing effectiveness of managerial decisions in field of organizing passenger traffic.
sections are characterized by the formation of the main passenger traffic between the stations of destination and arrival of the train.

Lines of the 2nd category - lines passing through the regions of the Russian Federation where there is, but the demand of the population for transport services by local and suburban trains is not fully provided, as a result of which passenger trains running along these lines play the role of serving the population and have many intermediate stops for boarding disembarkation of passengers. The sections of lines of the II category include single-track sections with an average intensity of freight and passenger traffic, including stations with a consistently high passenger formation, and located in densely populated areas. On the one hand, such sections are accompanied by a road network, which makes organizing the movement of commuter trains unprofitable, on the other hand, motor transport, which does not fully satisfy the population’s need for commuter services, forces long-distance trains to perform this function by assigning many intermediate stops for pick-up and drop-off passengers. For transport services in such regions, trailed or non-stop rail cars can be used.

Lines of the 3rd category are mixed lines (double-track lines, single-track lines with double-track inserts) on which there are a large number of intermediate stopping points and a small passenger flow. These are areas where route network optimization can be carried out. Instead of canceled trains, trailed or direct transports, multimodal transportation can be arranged.

Lines of the 4th category - lines on which multimodal passenger transportation can be used throughout the year on an ongoing basis. In this option, rail transport as having the maximum carrying capacity will perform the main part of the route, and motor transport - the transporting function of the "last mile".

Lines of the 5th category are lines on which seasonal multimodal transport can be arranged: in summer to vacation spots at sea, winter transport to ski resorts.

4. Conclusions
Passenger traffic directly affects the completeness of the implementation of economic relations within the country and abroad, as well as the ability to move all social layers of the population to meet production and personal needs [14]. The organization of multimodal transportation of passengers is aimed at reducing the outflow of passengers to other modes of transport, thereby significantly improving the quality and comfort of transportation [15].

Nowadays, there is a tendency to reduce the number of direct routes. The decrease in the number of direct wagons is due to increasing competitive influence from airlines and vehicles. Accordingly, there is a need to solve the problem of maintaining the share of passenger traffic. This problem can be solved either by developing direct connections, or by switching to multimodal transportation with the condition of coordinating the time of transfer.

In today’s world, the transportation management system should be adapted to the new principles of managing the passenger complex - customer-oriented approaches to satisfying the demand, developing the competitive advantages of rail transport, expanding transport accessibility for the population through regular traffic between the regions of the Russian Federation. It is required to develop criteria for putting multimodal routes into circulation, a procedure for evaluating the operational work of the rolling stock. New technological solutions should be based on the use of modern information technologies that ensure the monitoring of operational and analytical characteristics for all passenger trains running on the infrastructure of the Russian Railways JSC.

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