Coordination of development of transport engineering enterprises capacity with high-speed traffic volume

A T Romanova¹, Yu M Luzhnov² and I S Nasonova¹,*

¹Russian University of Transport (MIIT), Moscow, Russia
²JSC Railway Research Institute (VNIIZHT), Moscow, Russian Federation
*tribenerg@gmail.com

Abstract. The paper presents a model of interaction between an enterprise customer of a vehicle and a national enterprise of transport engineering, which ensures coordination of the interests of consumers and the manufacturer, considering the estimated demand for passenger transportation in high-speed traffic.

1. Introduction
Rail transport plays an important role in the socio-economic development of the country and in the realization of the rights of individuals to move [1-3]. As it is known, under certain conditions, high-speed highways ensure dynamic development of adjoining regions, form territorial transport clusters, which are the core of regional development. The main problem analyzed in the work is development of production capacities of domestic transport engineering enterprises in accordance with the estimated passenger traffic in high-speed traffic. The production capacities of domestic transport engineering enterprises must be oriented not only to the production of the estimated number of high-speed rolling stock, but also to the repair work associated with its operation.

2. Algorithm for determining the volume of high-speed traffic in the Russian Federation
To calculate the estimated volumes of passenger traffic in high-speed traffic in the Russian Federation, an algorithm has been developed that includes the following blocks:
– selection of a route for launching high-speed traffic based on the following criteria: economic development index, population of gravitational areas, population density, share of urban (more mobile) population, presence of stable passenger traffic;
– analysis of the competitiveness of modes of transport based on indicators of traffic intensity, distance, travel time, average tariff, comfort;
– estimation of the passenger traffic size based on the population dynamics of the regions of gravity, population welfare, parameters of transport services (speed, tariff).

In the algorithm for assessing redistribution of passenger traffic, an expert approach [1] is used with:
– segmentation of the industry market by different consumer groups;
– determining the importance of certain consumer requirements in each segment of the industry market;
– characteristics of consumer properties that are offered during implementation of the high-speed traffic project;
− formation of reference characteristics of services by competing companies in the industry market;
− assessing the level of competitiveness of products/services sold by each company in each segment of the industry market;
− determination of the relative deviation between the level of competitiveness that can be provided for the consumer segment during implementation of the investment project and which was provided earlier, before implementation of the project;
− determination of the total value of the relative change in consumer demand for a product/service that a company implementing an investment project can provide for each segment of consumers. The calculation is based on the relative deviation between the level of competitiveness of a product/service and the levels of competitiveness that other companies provide. The total value of the relative change in consumer demand is determined considering the share of each segment of consumers in the industry market;
− determining a new level of demand for high-speed traffic, as well as other types of traffic for each segment. The estimation for consumer segments can be made on basis of historical data for each of them or on basis of scenario estimates.

The expert assessment was carried out using the paired comparison method.

3. Model of interaction between the corporate customer and the vehicle manufacturing enterprise
The output data of the algorithm described in clause 2 is the estimated passenger traffic, which is the basis for determining the required number of high-speed rolling stock.

The model of interaction between the corporate customer and the manufacturing enterprise of high-speed rolling stock is based on solving the following problems:
− the manufacturing enterprise provides production and repairs that cannot be carried out at the premises of the corporate customer;
− the corporate customer provides maintenance and repair work at the premises of the centers created in the depot.

Solving these tasks requires:
− search for new suppliers;
− expansion of warehouses of materials, components that perform supply function;
− expansion of production shops (bogies, bodies, power-, traction-, pneumatic equipment, etc.) and other shops (procurement, testing (apparatus, devices), assembly, etc.);
− expansion of finished goods warehouses;
− reorganization of design and engineering departments;
− reorganization of management departments involved in the development of regulatory documentation, organizing production cycles, working with external enterprises, engaged in maintaining various forms of reporting, etc.;
− creation of departments dealing with the organization of work on rolling stock running, as well as on elimination of identified violations in the operation of the vehicle.

The system of interaction and necessary transformations is shown schematically in Figure 1.
When solving problems, the existing production areas, equipment and the possibilities of their use are taken into account.

Based on the assessment results of the existing production capacity, the need for its increase is assessed (construction of additional workshops, purchase of new equipment (or, in case of insufficient equipment loading, redistribution of operations between the existing equipment or separation of equipment from the existing one for new operations, an increase in labor resources).

The task of determining the required production capacities and their dynamics is solved under the following assumptions:
the number of high-speed rolling stock cars of a particular class of service is determined by consumer demand, i.e. when forming the composition of high-speed rolling stock, the average car population and passenger demand are taken into account;

- the number of cars is determined by the permissible length of high-speed rolling stock and the length of the passenger platform (i.e. considering the infrastructure component);

- the number of high-speed rolling stock is determined by the turnaround time (i.e. the operational component).

In addition, the annual demand for the required number of cars and the number of high-speed rolling stock produced is determined, considering its commissioning in previous periods and disposal, i.e. considering the service life of the rolling stock and the time between repairs. Since at the initial stage there will be an actual fleet of high-speed rolling stock, the existing fleet should be taken into account when forecasting for a period of 10-15 years. Therefore, the production volume of high-speed rolling stock in each subsequent period is determined as the difference between the predicted demand for rolling stock and its available quantity according to formula (1).

\[
\Delta N = [N * (t_{пр}) - N * (t_{пр} - 1)] * (1 + k)
\]  

(1)

\(\Delta N\) – changing the number of required high-speed rolling stock;

\(t_{пр}\) – forecast period;

\(t_{пр} - 1\) – period of time preceding the forecast period;

\(k\) – coefficient, which considers the share of the fleet being serviced.

The increase in production capacity \((M_{нпр.мощ.})\) is understood to mean its necessary increase, which is determined based on the difference between the planned production capacity \((M_{пл})\) and the current production capacity \((M_{тек})\). This indicator is consolidated and is calculated by the formula (2):

\[
M_{нпр.мощ.} = M_{пл} - M_{тек}
\]  

(2)

The planned capacity is calculated according to the required increase in high-speed rolling stock and the production of the required number of spare parts (formula (3)).

\[
M_{пл} = n * (1 + \Delta \delta_{м.ч.})
\]  

(3)

\(n\) – number of high-speed rolling stock units;

\(\Delta \delta_{м.ч.}\) – increase in capacities to produce spare parts related to the production of high-speed rolling stock, reduced to rolling stock units.

Production capacity characterizes not only the maximum volume of production in a certain period but is the value of the production potential of the enterprise, which, taking into account the available (financial, material, labor) resources, contributes to an increase in carrying capacity on the sections of high-speed railways and increasing its competitiveness in the transport market.

When forming the price of high-speed rolling stock, it is necessary to coordinate interests of all three entities (passengers, the carrier and the rolling stock manufacturer) participating in the functioning of the value chain and business processes in it. Their interaction is complex. In the study, the upper price limit for new products is determined, which has the form presented in expression (4).

\[
n^Н*\Pi^Н ≤ \frac{[(\Delta C - \Delta C^H) + (\bar{P}_{am} + \bar{E}_H)^n^Н]}{N^Н} + \frac{3P^Н}{(1+\alpha_{сп} + p^H_{am} + E_H)}
\]  

(4)

\(n, n^Н\) – old and new volume of product supplies;

\(\Pi, \Pi^Н\) – the price for similar products on the market and the price for new products of the corporate customer;

\(\Delta C, \Delta C^H\) – accordingly, part of the cost of a unit of rolling stock with the old and new technical equipment of production at the manufacturing enterprise, minus depreciation charges;

\(P_{am}, P_{am}^H\) – depreciation rate for old and new equipment;

\(E_H\) – standard efficiency ratio, defined as a unit divided by the technology obsolescence period;

\(N^Н\) – release of a new volume of products by the manufacturer of new equipment;
\( 3^p \Sigma \) – operating costs of the corporate customer;
\( \alpha_{kp} \) – loan interest rate.

This expression is obtained during:
- assessment of the annual economic effect of the carrier - the customer of high-speed rolling stock based on the difference between its old and new reduced costs in terms of a new volume of products;
- division of the effect between the manufacturing enterprise of the new high-speed rolling stock and the corporate customer (the effect is divided so that profitability of the consumer’s costs when using the new equipment is not lower than the loan interest rate);
- dependence of the annual economic effect on the price of new products of the corporate customer.

The interests of passengers are reflected through the relationship between passenger fares, the level of competitiveness of high-speed traffic in the transport services market, and income of the population.

4. Conclusion

The approaches outlined in the work for estimating passenger traffic, determining the required amount of high-speed rolling stock, forming a model of interaction between the corporate customer and the manufacturing enterprise, as well as assessing the upper price limit for high-speed rolling stock enable to take into account the chain of interests of interacting business entities:
- a consumer of the first level (future passengers who are interested in receiving innovative services on a promising line, taking into account optimal tariff plans, travel time, comfort);
- a consumer of the second level (a corporate customer for whom it is important to have high-quality and safe in operation high-speed rolling stock, considering the possibility of repair work by the corporate customer throughout the entire life cycle, thereby satisfying the needs of the population in transportation and having proceeds from the sold travel documents and additional services sold);
- a manufacturing enterprise (a national transport engineering enterprise, which finds important a clear distribution of tasks with a corporate customer, an optimum increase in production capacity, the proper use of high-speed rolling stock, which will increase its service life and will help reduce costs and increase profits).

An important criterion for this chain is the socio-economic effect, which is of a multiplicative nature, and its important component is an increase in the business activity of citizens.

References

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