THE METHODOLOGY FOR CALCULATION OF INDICATORS RELATED TO PASSENGER TRAINS OF UNCHANGED COMPOSITION

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ABSTRACT

Using the example of railway direction Moscow–Penza the article provides economic justification for the use of passenger trains of unchanged composition in growing competition environment in the transport market. At the same time the role of strengthening customer loyalty in attracting additional passenger flow and the value of proposed methodological tools that provide the calculation of total costs for organization of trains with rigid train scheme, as well as revenue and payback indicators of capital investment are estimated.

Keywords: transport market, competition, railway, train of unchanged composition, passenger flow, investments, payback, economic efficiency.

Background. *Most long-distance passenger trains have a modular scheme of composition. It consists of cars «train's core» which are always included in the train scheme and optional cars, which number may increase or decrease depending on the dynamics of demand. Between the same type and class of service cars «train's core» and optional cars there are differences in age and quality characteristics that influence perception of the level of transport services by a passenger, taking into account the same tariff fare. In some cases, passengers form negative experience of a journey by rail due to mismatch of the claimed quality of transport service with expectations. In contrast, to improve customer service levels at a number of large main directions of the network of JSC Russian Railways with stable volumes of demand we believe it is reasonable to assign a train with a rigid composition scheme (a composition does not change over a long period).*

Commissioning of trains of unchanged composition is one of the ways to attract additional passenger flow in increasing competition in the transport market. In cars of the same type and class of service in trains with a rigid composition scheme trains scheme services comparable in terms of quality that meet passengers' expectations can be offered to them. Match of services with expectations by railway companies creates customer's loyalty to the carrier [1].

Objective. *The objective of the authors is to consider methodology used for calculation of indicators related to passenger trains of unchanged composition.*

Methods. *The authors use general scientific methods, comparative analysis, economic assessment, evaluation approach.*

Results. *The train of unchanged composition means a train of a fixed scheme in which the number, types and order of cars remain the same for a long period of time. This feature suggests that the area of rational use of such trains is limited to directions with a large and stable passenger flow [2]. Given that passenger demand is uneven [3], the organization of transportation process on the basis of trains of unchanged composition should be considered in conjunction with the use of trains of modular scheme. A substantial part of passenger flow is serviced by trains of rigid scheme and a certain amount of demand – by modular trains (Pic. 1).*

The expediency of commissioning of trains with rigid composition scheme is based on the study of the transport market. The main stages of analytical work should include:

1) market research;

2) demand forecast;

3) analysis of competitive environment of the transport market;

4) analysis of the potential of car fleet;

5) justification of conditions (requirements) to ensure effectiveness of commissioning of trains with a rigid composition scheme.

The first phase includes an assessment of characteristics of demand in volume and structure of passenger flow, the study of quality indicators of transportation and their dynamics over time.

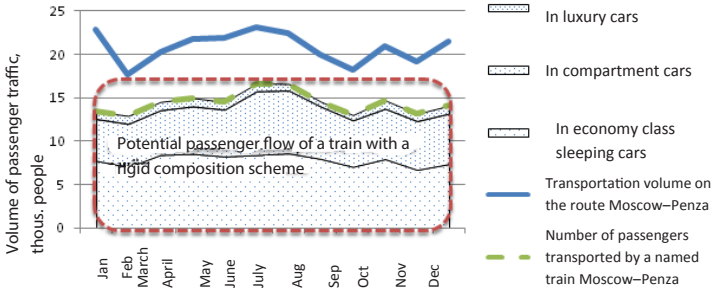
The second phase. Commissioning of trains with a rigid composition scheme is taken for a long term, in this connection it is necessary to get data and predict traffic volumes at least for a medium term [4].

The analysis of competitive environment, made in the third phase, is carried out to search for opportunities to increase the market share of railways in the transport market.

As for the potential of rolling stock (fourth stage), there is an assessment of the state of existing cars, there is a selection of those that meet specified conditions: the same service life, uniform specifications and intervals of scheduled repairs.

Justification of efficiency of commissioning of trains with rigid composition scheme is the fifth phase. At this stage, a comprehensive analysis and generalization of results are carried out, requirements are defined to ensure the use of technologies designed for options of unchanged composition.

According to the research [5, 6], using data of actual passenger flows ten major directions are



Pic. 1. Aggregate demand on the route Moscow–Penza, and its coverage by a named train.

Table 1

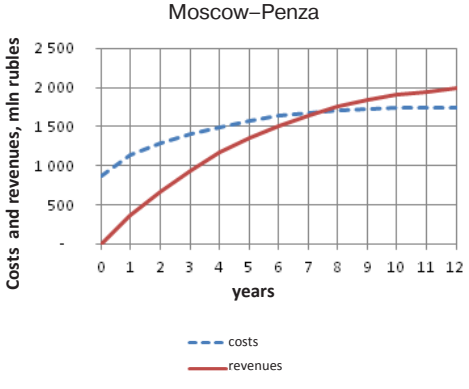
The list of railway directions, meeting requirements of stability and regularity of demand

№	Direction	Number of passengers, thous.people	Uneveness coefficient	Length of the route, km	The amount of population in corresponding points, mln people
1	Moscow – St.Petersburg	6 818	1,2	650	19,9
2	Moscow – Nizhny Novgorod	1 668	1,1	444	16,6
3	Moscow – Yaroslavl	1 026	1	793	16,1
4	Moscow – Kazan	1 012	1,1	282	15,1
5	Moscow – Saratov	941	1,1	856	15,3
6	Moscow – Voronezh	715	1,1	583	15,7
7	Moscow – Belgorod	656	1,1	697	15,0
8	Moscow – Samara	653	1,1	1044	17,0
9	Moscow – Kirov	629	1,2	917	15,3
10	Moscow – Penza	552	1,1	710	15,4

Table 2

Discounted costs and revenues from-year-to-year illustrated by the direction Moscow–Penza

Years	Discounted costs, mln rub	Discounted revenues, mln rub
0	872,2	0,0
1	1 138,6	361,3
2	1 281,2	672,0
3	1 399,3	937,7
4	1 495,6	1 163,5
5	1 572,7	1 353,8
6	1 633,0	1 512,7
7	1 678,4	1 643,9
8	1 710,8	1 750,5
9	1 731,8	1 835,5
10	1 743,0	1 901,5
11	1 745,6	1 950,8
12	1 740,7	1 985,5



Pic. 2. Determination of minimum cost-effective scheme of trains of unchanged composition (illustrated by the direction Moscow–Penza).

allocated (Table 1), where it is reasonable to consider commissioning of trains with rigid composition scheme. They include traffic between Moscow and St. Petersburg, as well as major regional units of Central and Volga federal districts.

To assess cost-effectiveness of commissioning and operation of trains with a rigid composition scheme its own method is developed. Key economic indicators of the new project on rail transport (net present value and payback period) are calculated based on justification of the sum of current effects for entire accounting period, reduced to the initial step, or as a result of excess of integral results over integral costs [7]. Payback period or the period of investment return is time from the start of project implementation, during which the integral effect becomes non-negative [8]. Cost-effectiveness analysis is performed for the entire period of the project life cycle. In accordance with the standard of FPC [9] trains of enhanced comfort are formed of cars not older than 12 years – it is a term taken as a calculation horizon. The discount rate is then determined based on the current value of refinancing rate of the Central Bank of the Russian Federation.

Study on economic performance of the train with a rigid composition scheme includes an analysis of the structure of expenditure and revenue, on the basis of which criteria are formulated for loss-free (cost-effective) operation for the entire period of the project life cycle. Total costs consist of the costs for purchase of new rolling stock and its operation. The cost of one car of each type is determined by the reported data of the manufacturer. The number of cars of various types required for formation of a train of a rigid scheme, is established on the basis of information on distribution of demand for certain types of them. The required number of train compositions is planned on the basis of turnover time and regularity of trips.

Operating costs include conditional permanent and dependent expenditures. The latter consist of own expenses of JSC FPC to transport passengers, to pay JSC Russian Railways for provision of infrastructure services, as well as locomotive rent. The costs of the carrier in terms of infrastructure component (including station) are associated with implementation of performance indicators: train-kilometers, car-kilometers and sent cars. For each of them its own fare level is set: I1, I2, I3. Contract for locomotives rent provides for in addition to payment

for operation of the machine itself, also payment for provision of leased locomotives with fuel, seasonal heating of passenger cars in transit on electricity.

The costs associated with operating activity JSC FPC, calculated for a specific train of a rigid scheme are defined by the method of single consumable rates related to the following measuring indicators: car-hour of a passenger car in the train (car-hour), car-kilometer train operation (car-km), car-hours for transportation of passengers in train movement (car-hour in motion), the number of passengers sent in train (pass.) and number of passenger cars sent in a train (car) [10, 11]. The results of calculation of total discounted costs of the carrier for purchase of new rolling stock and its commissioning illustrated by the direction of Moscow-Penza are given in Table 2.

Profitable revenues are generated through sale of travel documents (core business) and provision of related services (catering, etc.). In general, income for one assignment of a train is defined as a product of average ticket price, number of cars in the train, and average number of passengers in a passenger car. Evidence for calculation can be obtained from the «Express-3» analytic database system. Calculation of net present value from-year-to-year is reflected in Table 2.

According to calculations made discounted revenues for the present project exceed discounted costs for the eighth year from the date of commissioning of a train of unchanged composition, which is shown in Pic. 2. The intersection of curves of discounted values of costs and revenues is a moment at which the integral effect becomes zero and is a graphic reflection of payback period of capital investment. In the future, integrated cash flow generated by the project, takes positive values, indicating economic efficiency of commissioning of trains of unchanged composition for the direction Moscow–Penza.

Conclusion.

1. Commissioning of trains of unchanged composition is one of the ways of attracting additional passenger flow in growing competition in the transport market by strengthening customer loyalty.

2. A method for evaluating economic efficiency of commissioning of trains of a rigid scheme is developed that provides calculation of total project costs, revenues and payback indicators of capital investment.

3. In accordance with the established methodology control calculations were conducted on the example of the direction Moscow–Penza, according to which payback period of capital investment for commissioning of trains of unchanged composition is less than 8 years. A positive net present value leads to the conclusion that the project in question can be considered cost-effective.

REFERENCES

1. Akulov, M. P. Meeting demands and expectations of passengers [*Otvechaja trebovanijam i ozhidanijam passazhirov*]. *Zheleznodorozhnyj transport*, 2015, Iss. 2, pp. 10–12.

2. Hiroshi Okada. Features and Economic and Social Effects of The Shinkansen. *Japan Railway & Transport Review*, Sep 1994, Iss. 3, pp. 9–16.

3. Niels van Oort, Marc Drost, Ties Brands, Menno Yap. Data-driven public transport ridership prediction approach including comfort aspects // Conference on Advanced Systems in Public Transport 2015 (CASPT 2015). July 2015. [Electoric source]: http://nielsvanoort.weblog.tudelft.nl/files/2015/05/Oort-et-al-Datadriven-PT-modelling-CASPT2015FullPaperFinal.pdf. Last accessed 08.04.2016.

4. Bernd Scholz-Reiter, Jens Heger and Christian Meinecke. Integration of demand forecasts in ABC–XYZ analysis: practical investigation at an industrial company. *International Journal of Productivity and Performance Management*, Vol. 61, 2012, Iss.4, pp. 445–451.

5. Makarova, E. A., Sokolovsky, A. V. Classification of railway directions in terms of volume of passenger operation on the basis of ACS «Express» [*Klassifikacija zheleznodorozhnyh napravlenij po ob'jomam passazhirskoj raboty na baze ASU «Ekspress»*]. Rail transport at the present stage of development: Proceedings. Ed. by B. M. Lapidus, G. V. Gogrichiani. Moscow, VMG-Print publ., 2014, pp. 57–63.

6. Makarova, E. A., Sokolovsky, A. V. Methodology of analytical studies to determine the feasibility of commissioning of trains with rigid composition scheme [*Metodika analiticheskih issledovanij dlja opredelenija celesoobraznosti vvoda v obrashhenie poezdov s zhjostkoj shemoj sostava*]. *Vestnik VNIIZhT*, 2014, Iss. 4, pp. 33–38.

7. Guidelines on assessment of investment projects in rail transport [*Metodicheskie rekomendacii po ocenke investicionnyh proektov na zheleznodorozhnom transporte*]. Moscow, MPS publ., 1998, 123 p.

8. Williams, J. R., *et al.* Financial and Managerial Accounting. McGraw-Hill, 2012. 1117 pp.

9. STO FPC1.05.006.2012 «Passenger service in trains formed by JSC Federal Passenger Company [*STO FPK 1.05.006.2012 «Obsluzhivanie passazhirov v poezdah formirovanija otkrytogo akcionernogo obshhestva «Federal'naja passazhirskaja kompanija»*].

10. The order of separate accounting of revenues and expenses by subjects of natural monopolies in the field of rail transportation. 2014. Approved by the order of Ministry of Transport of Russia on August 12, 2014 № 225 [*Porjadok vedenija razdel'nogo uchjota dohodov i rashodov sub'ektami estestvennyh monopolij v sfere zheleznodorozhnyh perevozok. 2014. Utverzhdjon prikazom Mintransa Rossii ot 12 avgusta 2014 g. № 225*].

11. Miroshnichenko, O. F., Oginskaya, A. E. New methodological approaches in determining the cost-effectiveness of long-distance passenger train in the conditions of functioning of JSC FPC [*Novye metodicheskie podhody pri opredelenii ekonomicheskoj effektivnosti passazhirskogo poezda dal'nego sledovanija v uslovijah funkcionirovanija OAO «FPK»*]. *Vestnik VNIIZhT*, 2013, Iss. 5, pp. 3–6.

12. Miroshnichenko, O. F., Morozova, M. V., Fadeykina, N. V. Evaluation of cost of long-distance passenger transportation in the Federal Passenger Company [*Ocenka sebestoimosti passazhirskih perevozok dal'nego sledovanija v Federal'noj passazhirskoj kompanii*]. *Zheleznodorozhnyj transport*, 2011, Iss. 10, pp. 63–66. ●

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