Methods of Prediction of Railway Passenger Traffic Volume

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Abstract - The article reviews and describes methods for predicting the railway passenger traffic. Definitely effective methods and models for improvement of rail transport.

Key words - railway, passenger traffic volume, predication, modeling, statistical methods, extrapolation

I. Statement of the problem

There is a steady increase in the role of the transport sector on a national scale for today. It is associated with high social importance of transport for passengers, which means a high rate of urban development, which requires ensuring greater mobility of people. Modern society needs constant increase traffic, achieve higher reliability, safety and quality. It requires for increased costs on infrastructure improvement of the transport network and transforming it into a flexible, highly controlled logistics system. This significantly increases the risk of investment, except for the patterns of development of the transport network, the distribution of loading areas. Ignoring these laws leads to frequent formation overload (underload) separate railway lines and nodes.

Prediction passenger provides a balanced decision on an adjustment to the organization of passengers additional flights. Monitoring the dynamics of traffic can quickly make management decisions that seek to satisfy the demand for transportation.

II. Analysis of publications and research

In the development of research on the investigation of regulation volume of passenger trains, maintenance of plants, determination of optimal schemes of forming trains, application of information technology in service work, have made such a great contribution to academics and practice: V.M.Akulinichev, I.M.Aksenov, B. I.Bobrovskyy, T.V.Butko, I.V.Berestov, P.S.Hruntov, M.I.Danko, V.K.Dolya, I.V.Zhukovytskyy, F.P.Kochnyev, VI. terns, Yu.F.Kulayev, B.Ye.Marchuk, Ye.V.Nahornyy, V.Ya.Nehrey, Yu.O.Pazoyskyy, H.N.Plahov, Ye.A.Sotnikov, B.I.Toropov, M.M.Cheptsov, V.A.Fedorov, A.N.Frolov, V.H.Shubko, S.P.Shumskyy, P.O.Yanovskyy and others.

On the basis of previous research found that does not fully take into account the impact of the dynamics of the structure and parameters of the passengers on the formation of the train. Moreover, the problem of determining the composition of passenger trains poorly studied: calculations performed by periods of maximum passenger is not rational to determine the need for different types of cars over the days, weeks, months and seasons, determining the number of wagon of different types established without the demand of passengers is not considered the impact of resource factors in determining whether reorganization of the train.

III. Unsolved problems

Nowadays not enough solved the problem of choosing effective methods for the prediction for the improvement of passenger rail transport, while taking into account the influence of the dynamics of the structure and parameters of the passengers on the formation of the train

IV. Objective

Finding effective methods for optimization and rationalization of economic flows with minimum costs in the rail sector.

V. The main research results

Prediction of passenger flows is an essential and integral part of the complex process of development of railway transport, ensuring the provision of quality services to the population of the country related to transportation. Since reliable estimates of transport work depends on technology and efficiency of the entire rail passenger terminal. Similarly, freight transportation, where almost all technical and technological calculations are based on the planned scope of work, resulting in cars, on the basis of similar calculations of passenger traffic are scheduled passengers. Their sheer size and irregularity of passenger time determine the need for rolling stock, road development and maintenance a snap passenger and passenger industrial plants, etc. [4].

Prediction based on passenger statistics on passenger derived from various forms of statistical reporting adopted at the railways. [2]

At present, the theory and practice of forecasting passenger increasingly beginning to use statistical forecasting methods, including methods of steam and multiple correlation with the following benefits:

- simplicity of obtaining predictive dependency in general and comparative universality of its application;
- estimation uncertainty of input information on the degree of accuracy of prediction;
- a high degree of objectivity, etc.

Applying the methods of correlation analysis for the prediction of passenger rail transport, it is important to establish the limits of validity. This should be followed the following basic assumptions:

- general laws that describe the trend of the past, do not undergo significant changes in the future;
- Increase (decrease) in passenger rail is smooth in (Evolutionary) trajectory of the time series, the correlation rail transportation filtration fluctuations
- factors that affect the volume of passenger traffic are mutually independent variables;
- the factors are given without errors;
- known in advance the type of regression (type of model).

One of the most common methods of prediction of railway passenger traffic volume, based on the method of correlation analysis is extrapolation. The typical and most applicable method of extrapolation is forecast to time series [4,5].

Extrapolation prediction of railway passenger traffic volume consists of four main steps:

- analysis of time series of traffic;
- filtering of random vibration time series;
- selecting the type of regression (model type) prediction;
- identifying predictive values of traffic.

In general, the change in the volume of tourists transport by rail in time can be represented by the regression equation of the form:

$$y = f(t) + \tau(t) \quad (1)$$

where $f(t)$ - the main trend in traffic volumes of passengers depending on time t; $\tau(t)$ - random fluctuations (noise).

When modeling the main trend to the second stage we must reduce random fluctuations in the time series.

Operation of pretreatmentprimary data random fluctuations and the allocation thereof, in which a clear underlying trend is called filtering (smoothing) of random vibrations [5].

Currently, the most commonly used methods of filtration are:

- filtering by unweighted moving average;
- filtering using weighted moving average
- filtering by finite differences;
- filtering through a special formulas obtained by using polynomials of different degree [1].

In this paper for the prediction of railway passenger traffic volume used - method of filtering through reckless moving average, the essence of which is to replace the original data time series average of over time, and the filtering process is carried out by the formulas:

$$s_t = (y_{t-1} + y_t + y_{t+1})/3; \quad (2)$$

$$s_{t-1} = (5y_{t-1} + 2y_t - y_{t+1})/6; \quad (3)$$

$$s_{t+1} = (-y_{t-1} + 2y_t + 5y_{t+1})/6; \quad (4)$$

where y_t, s_t - the value of the original and filtered functions at the midpoint;

y_{t-1}, s_{t-1} - the value of the original and filtered functions on the left side of the midpoint;

y_{t+1}, s_{t+1}- the value of the original and filtered functions on the right side of the midpoint.

The third phase extrapolation prediction of railway passenger traffic volume for the selection of type regression equation (mathematical model trend), which adequately describes the filtered time series.

To assess the correctness of the choice of analytical dependence (models) criterion is applied R.Fishera (F), which is defined as follows:

$$F = \frac{G^2_{com}}{G^2_{end}}; \quad (6)$$

$$G^2_{com} = \sum_{i=1}^{n} (y_i - \bar{y})^2/(n-1); \quad (7)$$

$$G^2_{end} = \sum_{i=1}^{n} (y_i - \tilde{y}t)^2/(n-2); \quad (8)$$

y_i - the value of the filtered output time series;

$\bar{y}$ - average value of the filtered output time series;

$\tilde{y}t$ - the value of the time series obtained by the regression equation [2].

The correctness of selection trendline equation is determined by comparing the F - test, calculated by formula (6), with some standard (tabular) F_T, as determined by a special table Fisher's exact test. If F appears more F_T ($F > F_T$), the equation can be used for trend When modeling the main trends. If these F is more than two then selected trendline equation corresponding largest value of F.

If $F < F_T$, the conclusion about the applicability of the regression equation should be regarded as unreasonable.

Conclusions

During the research it was considered prediction of railway passenger traffic volume based on passenger statistics. The analysis showed that the most effective is the method of extrapolation prediction of passenger traffic volume, which allows to analyze the time series of traffic volume, filter random vibration time series and on this basis to predict the volume of passenger traffic

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