# COST ANALYSIS OF PASSENGER TRANSPORTATION BY RAILWAY

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Passenger transportation by railway is fast, safe, convenient and affordable for people but it is usually not profitable for the state. Therefore, making passenger transportation profitable is a task of vital importance. Various calculations are used to optimise this process.
The paper considers the problems of economical passenger transportation which two models may describe: the first model is based on the assessment of income-expenses of separate services, while the second model is related to the assessment of expenses according to their types.

**Keywords:** *income, expenses, model, transportation, railway*

## 1. INTRODUCTION

One of the most important problems associated with railway transport in Europe is associated with losses experienced by passenger carriers. Now, only long international routes are profitable, while railway companies and carriers operating on local routes experience losses. The agreements between the companies providing transport services in particular regions and the authorities about the financial support of carriers experiencing losses on particular routes could help resolve this problem. The conditions of the above agreements may vary depending on the losses experienced by the companies on particular routes. Both profitable and unprofitable routes should be purchased in bidding. This could provide railway companies with a stimulus to search for reserves allowing them to reduce expenses. State control is needed to ensure that prices are not lowered at the expense of safety. The requirements for safety in transportation should be harmonized in various countries. The problem of passenger safety should be one of top priority in transport.

To attract the flows of passengers to railway transport, the conditions of travel should be considerably improved. Passengers are interested in fast, safe and comfortable transportation at reasonable cost. If changes are to be made, the schedules of various means of transport should be matched. Usually, railway schedules are matched with road transport schedules; however, higher flexibility is required from the railway transport as far as making up trains and their schedules is concerned.

Tariff policy should also be flexible, with cost corresponding to the value of provided services. Business class passengers, for instance, are mainly interested in trip duration and comfort, while cost is not so important for them. However, holidaymakers should be offered lower prices along with acceptable speed and comfort level because, otherwise, they will choose road transport providing cheaper though not so good services.

In considering the costs of passenger transportation by railway it is important not only to know the types of income and expenses but also to determine the weights of these types of expenses. This would allow us to take the appropriate actions aimed to reduce expenses and to increase profit.

## 2. A MODEL OF DETERMINING THE RELATIONSHIP BETWEEN INCOME AND EXPENSES DEPENDING ON A PARTICULAR UNIT, DEPARTMENT OR SERVICE

The following model may determine income and expenses of passenger transportation with respect to a particular unit:

$$\Delta = \sum I_{inc} + \sum E_{\exp}, \quad \text{EUR} \qquad (1)$$

where $\sum I_{inc}$ – total income obtained from passenger transportation, Lt;
$\sum E_{\exp}$ – overall expenses, Lt.

The income will consist of:

$$\sum I_{inc} = p_1 I_{lc} + p_2 I_{ic}, \quad \text{EUR} \tag{2}$$

where $I_{lc}$ – income obtained from local transportation, Lt;
$I_{ic}$ – income obtained from international transportation, Lt;
$p_1$ ir $p_2$ – efficient, which estimates value of income.

The expenses will consist of the following:

$$\sum E_{\exp} = n_1 E_c + n_2 E_{ps} + n_3 E_r + n_4 E_a + n_5 E_l + n_6 E_t + n_7 E_{ca} + n_8 E_b + n_9 E_{es} + n_{10} E_o, \quad \text{E}UR \tag{3}$$

where $E_c$ – expenses of wagon depot, EUR;
$E_{ps}$ – expenses of a unit providing services to passengers, EUR;
$E_r$ – expenses of road maintenance department, EUR;
$E_a$ – expenses of automation and communication department, EUR;
$E_l$ – expenses of locomotive depot, EUR;
$E_t$ – expenses of traffic organization, EUR;
$E_{ca}$ – expenses of the administration department of a company EUR;
$E_b$ – expenses of building and engineering equipment unit, EUR;
$E_{es}$ – expenses of power supplying unit, EUR;
$E_o$ – expenses of other departments and services (e.g. centre of diagnostics, security service, etc.), EUR;
$n_1, n_2, ..., n_{10}$ – weight coefficients of particular expenses.

Weight coefficients for evaluating various kinds of income are calculated as follows:

$$p_1 = \frac{I_{lc}}{\sum I_{inc}}, \tag{4}$$

$$p_2 = \frac{I_{ic}}{\sum I_{inc}}. \tag{5}$$

Weight coefficients for assessing the expenses of particular units, departments or services are calculated in the following way:

$$n_1 = \frac{E_c}{\sum E_{\exp}}, \tag{6}$$

$$n_2 = \frac{E_{ps}}{\sum E_{\exp}} \text{ ir t.t.} \tag{7}$$

Since the expenses of the particular units vary considerably for local and international routes, the calculations of the expenses by formula 3 are made separately for each type of transportation.

The finite model for evaluating the expenses in passenger transportation will be of the form:

$$\begin{aligned}\Delta = &\left(0{,}28 I_{lc} + 0{,}72 I_{tic}\right) - \\ &-\left(0{,}02S'_c + 0{,}12S'_{ps} + 0{,}7S'_r + 0{,}05S'_a + 0{,}26S'_l + 0{,}1S'_t + 0{,}02S'_{ca} + 0{,}02S'_b + 0{,}06S'_{es}\right) - \\ &-\left(0{,}04S''_c + 0{,}07S''_{ps} + 0{,}05S''_r + 0{,}01S''_a + 0{,}07S''_l + 0{,}02S''_t + 0{,}01S''_{ca} + 0{,}01S''_{es} + 0{,}01S''_o\right),\end{aligned} \tag{8}$$

where $S'$ and $S''$ are the respective expenses of particular units on local and international routes. The numerical values of weight coefficients are obtained from the data provided by Lithuanian railways.

As shown by the model of assessing expenses depending on a particular unit, the largest weight in passenger transportation expenses is found for the following departments and services:

– on local routes – the locomotive depot, with the weight of 0.26; followed by passenger service department – 0.12; traffic department – 0.1; road maintenance department – 0.07; automation, communication and power supply – 0.05 each.

– on international routes – passenger service department and the locomotive depot – 0.07 each; road maintenance department – 0.05; wagon depot – 0.04.

## 3. THE MODEL OF DETERMINING THE RELATIONSHIP BETWEEN INCOME AND EXPENSES DEPENDING ON THE TYPE OF EXPENSES

Income and expenses in passenger transportation may also be assessed according to the type of expenses by the following model:

$$\Delta = \sum I_{inc} - \sum E_{\exp}\ , \tag{9}$$

where $\sum I_{inc}$ – total income obtained from passenger transportation (by formula 2)

$\sum E_{\exp}$ – overall expenses, EUR;

The sum of expenses depending on their types will be as follows:

$$\sum E_{\exp\ t} = c_1 \sum E_{\exp\ dir} + c_2 \sum E_{\exp\ indir} + c_3 \sum E_{\exp\ act}, \tag{10}$$

where $E_{\exp\ dir}$ – direct expenses, EUR;

$E_{\exp\ indir}$ – indirect (variable) expenses, EUR;

$E_{\exp\ act}$ – operational expenses, EUR;

$c_1, c_2, c_3$ – weight coefficients of particular types of expenses.

$$c_1 = \frac{E_{\exp\ dir}}{\sum E_{\exp}}. \tag{11}$$

$$c_2 = \frac{E_{\exp\ indir}}{\sum E_{\exp}}. \tag{12}$$

$$c_3 = \frac{E_{\exp\ act}}{\sum E_{\exp}}. \tag{13}$$

Having calculated the coefficients $c_1$, $c_2$, $c_3$ based on the data provided by Lithuanian railways, we obtained the following general model of income-expenses:

$$\Delta = 0{,}28 I_{lc} + 0{,}72 I_{ic} - 0{,}70 E_{\exp dir} - 0{,}12 E_{\exp\ indir} - 0{,}18 E_{\exp\ act} \qquad (14)$$

The expenses will consist of:

$$\sum E_{\exp} = k_1 \cdot E_{fc} + k_2 \cdot E_{wp} + k_3 \cdot E_{si} + k_4 \cdot E_{cr} + k_5 \cdot E_m + k_6 \cdot E_d + k_7 \cdot E_o, \qquad (15)$$

where $E_{fc}$ – fuel cost, EUR;

$E_{wp}$ – work payment, EUR;

$E_{si}$ – social insurance costs, EUR;

$E_{cr}$ – capital repair cost, EUR;

$E_m$ – material costs, EUR;

$E_d$ – depreciation expenses, EUR;

$E_o$ – other expenses, EUR;

$k_1, k_2, ..., k_7$ – weight coefficients of particular expenses

Having calculated the values of coefficients $k_1$, $k_2$, $k_3$ based on the data provided by Lithuanian railway, we obtained the following income-expenses model.

$$\begin{aligned} \Delta &= \left(0{,}28 P_{vv} + 0{,}72 P_{tv}\right) - \\ &- \left(0{,}15 E_{fc} + 0{,}39 E_{wp} + 0{,}14 E_{si} + 0{,}02 E_{cr} + 0{,}06 E_m + 0{,}19 E_d + 0{,}09 E_o\right). \end{aligned} \qquad (16)$$

## 4. CONCLUSION

To reduce the expenses in passenger transportation, the expenses of the locomotive depots (especially on local routes) as well as expenses of passenger service, traffic and road maintenance departments (on local routes) should be decreased.

As shown by the model (formula 14), income obtained from international passenger transportation makes the largest part – 0.72, while the income on local routes makes only a third of the total income – 0.28. Direct expenses make 0.70, i.e. the largest portion of overall expenses, followed by operational expenses – 0.18 and indirect (variable) expenses – 0.12.

According to the income-expenses model (formula 16), work payment makes 0.39, i.e. the largest part of expenses, followed by depreciation expenses – 0.19, fuel costs – 0.15 and social insurance – 0.14.

The suggested models may be used for assessing the expenses and effectively distributing them among units and departments, providing various services as well as for obtaining the maximum profit.

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