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## Quality evaluation of the long-distance bus and train transportation in Hungary

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### Abstract

The quality offered by railway and national bus providers (state and look of the vehicles, inner appearance, ticket purchasing options) plays a major part in the public transportation system in Hungary. These quality measurements influence passengers in their choice of travelling method. The presence of parallelism of railway and bus transportation is an actual problem in long-distance transportation in Hungary. The main purpose of the transportpolitics is to increase the role of the railway in the public transport system. Consequently, it is necessary to prefer and donate those transport modes, which need high infrastructure. Furthermore, maintaining or increasing the railway's competitiveness (for example: Budapest – Győr) is also required. In Hungary, both of the public transport modes are demanded compensation subsidy – because of the social discounts - by the government. Holding this subsidy in an optimal value is one of the most emphasizing task from the decision-making too. The solution of this problem lies not only in professional traffic organizing methods, but also regarding the needs of passengers and satisfying said needs. Defining the optimal demand for the development of this subject is based on interviewing passengers directly. The questions asked are specifically targeting perception of the quality of service. Based on this perception conclusions can be drawn regarding passengers' choice of transportation methods. The purpose of our subject is to use the results gotten from the questionnaires to give a general idea of the demands from the passenger's side, especially in case of co-existence of the possibility of transportation by bus and railway.

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## 1. Theoretical estimation of travelling

We can compare different modes of public transport's access times and distances – which are calculated from the data of timetables – between Budapest and the examined cities with regression analysis, which belongs to the family of Ritz methods. The regression functions create a linearly independent system, so we can't describe each function with the other functions' linear combination. Polynomials with even degree are well applicable to the interior range of the research, but they are not properly usable in the extreme locations. However, polynomials with odd degree fulfill the condition that the chosen function has to be suitable to typify the phenomenon at the extreme locations too.

The different polynomials with odd degree are derivable from the regression of  $n$  degree, (1)

$$f(x, \underline{a}) = a_1 + a_2x^1 + a_3x^2 + a_4x^3 + \dots + a_{n+1}x^n \quad (1)$$

, where we can define the  $\underline{a} = [a_1, a_2, a_3, \dots, a_{n+1}]$  unknowns with the equations, which is from functions (2), (3), (4).

$$1 \cdot a_1 + M[x_i]a_2 + \dots + M[x_i^n]a_{n+1} = M[y_i] \quad (2)$$

$$M[x_i]a_1 + M[x_i^2]a_2 + \dots + M[x_i^{n+1}]a_{n+1} = M[y_i x_i] \quad (3)$$

...

$$M[x_i^n]a_1 + M[x_i^{n+1}]a_2 + \dots + M[x_i^{2n}]a_{n+1} = M[y_i x_i^n] \quad (4)$$

In linear (first degree) regression a straight line fits the most on the given value pairs, which can be granted in the following form. (5)

$$f(x, \underline{a}) = a_1 + a_2x \quad (5)$$

In third degree regression the function we are looking for looks like (6).

$$f(x, \underline{a}) = a_1 + a_2x + a_3x^2 + a_4x^3 \quad (6)$$

Equations from the functions (1), (2), (3), (4) are necessary to specify the fifth degree polynomial, but the detailed explanation is complex, so it is not shown in this paper.

The quality of the aforementioned odd degree polynomial's application can be characterized with correlation analysis in which we can form a correlation coefficient ( $r$ ) to describe the connection between the examined variables. The values of the correlation coefficient are shown in Table 1. The more the polynomial fits the dataline, the bigger (but less than 1) the value of " $r$ " coefficient is.

Table 1. The value of the correlation coefficient using different polynomials.

Type of function/correlation coefficient	National bus	Train
Linear	0,93	0,89
Third degree polynomial	0,94	0,89
Fifth degree polynomial	0,94	0,91

Superposing the correct regression function on the data pairs (5), (6), it is stated, regarding the values of national bus service, the third degree polynomial results the lowest possible fault. Approximating with fifth degree polynomial eventuate the same coefficient value as third degree polynomial, so it is unnecessary to use it – it causes the complexities of calculation.

Examining the values of train, the linear regression function fits the most to the data pairs. Regarding Table 1, the fifth degree polynomial gives the optimum result, but for dataserie under 100 kilometers it can't be used, because at about 30 kilometers the reaching time value of the function would be 0 (Fig. 1. (a)).

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