DECISION MAKING METHOD USED FOR ELIMINATING THE ROAD AND RAILWAY PARALLELISM OF POINT TO POINT PASSENGER TRANSPORT SERVICES

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Abstract: Presentation of the possibilities of efficiency improvement in point-to-point passenger transport services. Determination of the possible types and the definition of the absolute and partial parallelism. Demonstration of the method used for eliminating the parallelisms. Presentation of the conditions required for the adoption of the ellaborated decision making method.

Keywords: passenger transport, parallelism, decision making method

1. Introduction

In order to increase the income several parallel transport services were developed by state owned road and railway firms, which thanks to the changing of the demographic and economic structure has become uneconomical or has not given us the national economy's optimum of the transport network. The efficiency of the transport system can be increased to a significant extent with the revise of passenger service sectors from the aspect of parallelism. This paper's topic is especially justified by the Hungarian Republic's regulation 2130/2006. (VINO. I 24.) which says that possibilities of road and railway parallelisms' elimination had to be revised in each county. As the resolution has not clearly disposed of what parallelism means, that's why we defined some basic concepts related to this . As regards the **absolute parallelism** we can speak about **road-railway, road- and railway parallelism,** i.e.(that is):
- **Road-railway parallelism** when the road- and railway stop's settlements correspond with each other;
- **Railway parallelism** the railway stop's settlements correspond with road stop's settlements, but vehicles serving on analyzed road route stop off at other settlements too;
- **Road parallelism** the road stop's settlements correspond with railway stop's settlements, but vehicles serving on analyzed railway route stop off at other settlements too;

We speak about partial parallelism when at least two amongst stops correspond with each other in both traffic sectors and the formerly presented cases of absolute parallelism are not held.

2. Aims of the paper

In this paper we find out the possible cases of traffic parallelisms with the help of mathematical formalisms. The traffic parallelisms have been determined in reference to the road- and railway traffic sectors. In addition we presented the conditions, where the fruition of them is a necessary part of the adoption of the ellaborated decision making method. During drafting of the condititons it was an important pont of view that the passenger-satisfaction (lead time of travelling) is not higher than an expected value. The decision making method is suitable for the proper legislation of the national economy's interest in the case of absolute and partial parallelisms.

3. Cases of the absolute and partial parallelism

Defining and understanding of definitions of different parallelism requires the mathematical relations, which can be clearly determined by relations (1) - (3).

– **Parallelism matrix,** which provides information about settlements of the passenger transport sector's service.

$$P=\left[p^{\gamma\beta}_{ij} \right] \quad i, j \rightarrow 1 .. n \tag{1}$$

where:

i, j: settlements of services of the road route no. γ and/or railway route no. β,

$p^{\gamma\beta}_{ij}=1$, if only the services of road route no.γ stop off at the settlement no. i,

$p^{\gamma\beta}_{ij}=2$, if only the services of railway route no. β stop off at the settlement no no. i,

$p^{\gamma\beta}_{ij}=3$,if both passenger transport sector's services stop off at the settlement no. i.

– **The set of the values in the main diagonal of parallelism matrix** has an outstanding significance regarding the definition of parallelism types, because it shows the values that result in some kind of parallelism.

$$\overline{A} \in p^{\gamma\beta}_{ij}, \text{ ahol } i=j \tag{2}$$

– **Number of the set's elements,** which shows the number of definitive settlements in terms of the examination.

$$\left| \overline{A} \right| = n \tag{3}$$

3. 1. Absolute parallelism

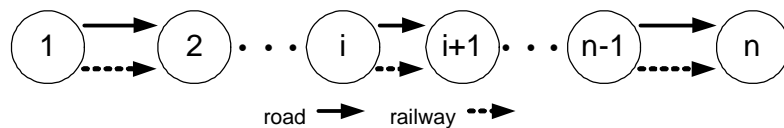Road-railway parallelism, when the road- and railway stop's settlements correspond with each other;

Figure 1. Road-railway parallelism

If $A_i \in \{3\}$ and i→1..n then we speak about road-railway parllelism

Railway parallelism, when the railway stop's settlements correspond with road stop's settlements, but vehicles serving on analyzed road route stop off at other settlements, as well;
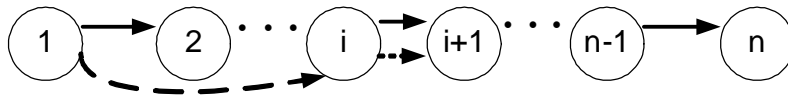

Figure 2. Railway parallelism

If $A_i \in \{1\}$ or $A_i \in \{3\}$ and i→1..n then we speak about railway parallelism

Road parallelism, when the road stop's settlements correspond with railway stop's settlements, but vehicles serving on the analyzed railway route stop off at other settlements as well.
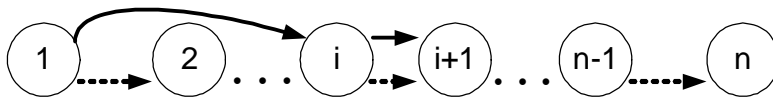

Figure 3. Road parallelism

If $A_i \in \{2\}$ or $A_i \in \{3\}$ and i→1..n, then we can speak about road parallelism.

3. 2. Partial parallelism

Figure 4. Partial parallelism

In that case, if $C \in \{x \mid x \in A \wedge x \in \{3\}\}$ and $n \leq |C| \geq 2$ we can speak about partial parallelism.

4. Method used for eliminating the parallelisms

In chapter 4 we will introduce the decision making method for elimination of the absolute and partial parallelisms, as well as the adoption of their condition.

4. 1. Conditions of the adaption of the decision making method

In those cases, where the parallelism can clearly be determined the conditions of the decision are the followings:
- if the run of lead time is directed unfavourable: the changing needs to stay under limit ε (the passenger satisfaction can be improved or in case of more favourable economic impacts it can be reduced slightly);
- the surplus values have to be higher than P_{elv}, as small growth involves unfavourable decision due to the increase of administration costs;
- the passenger traffic company, which receives the passenger traffic tasks, requires to possess with the right human- and mechanical capacity.

The following decision method can only take place in case of the fruition of the above mentioned conditions, otherwise there is no service elimination.

4. 2. Decision making method used for eliminating the parallelisms

Financial balance related to the rate no. λ of service no. i in route no. η of passenger traffic sector no. γ.

$$P_{\eta i \lambda}^{\gamma} = R_{\eta i \lambda}^{\gamma} - (K_{\ddot{u}\eta i \lambda}^{\gamma} + K_{s\eta i \lambda}^{\gamma} + K_{\ddot{u}\eta i \lambda}^{\gamma} + K_{b\eta i \lambda}^{\gamma} + K_{f\eta i \lambda}^{\gamma} + K_{j\eta i \lambda}^{\gamma}) \quad \gamma \in \{S; R\} \tag{1}$$

where:

▸ $K_{\ddot{u}\eta i \lambda}^{\gamma}$:fuel cost (fuel cost in connection with the rate no. λ of service no. i in the route no. η of traffic sector no. γ);

▸ $K_{s\eta i \lambda}^{\gamma}$:other material cost (prime cost of sold season ticket or ticket in connection with the rate no. λ of service no. i in the route no. η of traffic sector no. γ);

▸ $K_{b\eta i \lambda}^{\gamma}$: wage cost (wage cost for the rate no. λ of service no. i in the route no. η of traffic sector no. γ);

▸ $K_{f\eta i \lambda}^{\gamma}$:maintenance cost (maintenace cost for the rate no. λ of service no. i in the route no. η of traffic sector no. γ);

▸ $K_{j\eta i \lambda}^{\gamma}$:incidental expenses (motorway- and parking cost for the rate no. λ of service no. i in the route no. η of traffic sector no. γ);

▸ $R_{\eta i \lambda}^{\gamma}$: income for the rate no. λ of service no. i in the route no. η of traffic sector no. γ

components occuring in the case of railway's (S) and road's (R) services.

Financial balance related to the service no. i of passenger traffic sector no. γ in the route no. η.

$$P_{\eta i}^{\gamma} = (\sum_{\lambda=1}^{m} (R_{\eta i \lambda}^{\gamma} - K_{\ddot{u}\eta i \lambda}^{\gamma} + K_{s\eta i \lambda}^{\gamma} + K_{\ddot{u}\eta i \lambda}^{\gamma} + K_{b\eta i \lambda}^{\gamma} + K_{f\eta i \lambda}^{\gamma} + K_{j\eta i}^{\gamma}) \tag{2}$$

Financial balance of the passenger traffic sector no. γ in the route no. η.

$$P_{\eta}^{\gamma} = \sum_{i=1}^{m} \sum_{\lambda=1}^{n} (R_{\eta i \lambda}^{\gamma} - K_{\ddot{u}\eta i \lambda}^{\gamma} + K_{s\eta i \lambda}^{\gamma} + K_{\ddot{u}\eta i \lambda}^{\gamma} + K_{b\eta i \lambda}^{\gamma} + K_{f\eta i \lambda}^{\gamma} + K_{j\eta i \lambda}^{\gamma}) \tag{3}$$

Decision-making in the case of absolute parallelism:
– **Absolute parallelism***:*
   – If $P_{\eta}^{S} < P_{\eta}^{R}$ and $P_{elv} < P_{\eta}^{R} - P_{\eta}^{S}$, then vehicles of the road traffic receive services of railway route no. η.

– If $P_\eta^S > P_\eta^R$ and $P_{elv} < P_\eta^S - P_\eta^R$, then vehicles of the railway traffic receive services of road route no. η.

- **Road parallelism:**
  – If $P_\eta^S < P_\eta^R$ and $P_{elv} < P_\eta^R - P_\eta^S$, then vehicles of the road traffic receive services of railway route no. η.

- **Railway parallelism:**
  – If $P_\eta^S > P_\eta^R$ and $P_{elv} < P_\eta^S - P_\eta^R$, then vehicles of the railway traffic receive services of road route no. η.

Decision-making in the case of partial parallelism:

- If $P_{\eta i}^S < P_{\eta i}^R$ and $P_{elv} < P_{\eta i}^R - P_{\eta i}^S$ then vehicles of the road traffic receive tasks of railway service *no. i*

- If $P_{\eta i}^S > P_{\eta i}^R$ and $P_{elv} < P_{\eta i}^S - P_{\eta i}^R$ then vehicles of the railway traffic receive tasks of road service *no. i*

5. Summary

In this paper we have introduced a possible way of increasing efficiency of the passenger transport sectors. We have presented the possible cases of parallelism during passenger traffic tasks in case of different traffic sectors, i.e. the form of the absolute and partial parallelism. We have defined the conditions, that need to be accomplished to be able to apply the elaborated decision making method. The method is suitable for handling the cases of both the absolute and partial parallelism, as well as making the decisions related to this.

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