

MULTICRITERIA APPROACH FOR PSO SERVICES SELECTION IN RAIL SECTOR

Dragana MACURA¹
Predrag JOVANOVIĆ²

***Abstract** – In the Law on Railways of the Republic of Serbia, the minimum criteria for PSO service are defined. However, there is a limited budget for PSO services in rail sector. Consequently, there is a need to select the rail services which will become PSO services. How to select these services, which method to apply, which criteria are relevant – are the questions considered in this paper. Authors proposed the TOPSIS method for the PSO services ranking. The set of relevant criteria are defined, as well. It is assumed that the budget for rail PSO services is limited, so the final rail PSO services selection, including this constraint, is made with Excel Solver.*

***Keywords** – Public Service Obligation, Railway services, Railway service quality, TOPSIS.*

1. INTRODUCTION

The costs of passenger transport by rail cannot be covered only through revenues from tickets sold, which is why these services are economically unprofitable and subject to state subventions through a public transport obligation contract (PSO). However, certain restrictions are defined as well, ie the amount allocated from the budget for PSO trains is limited.

The whole process of defining PSO services can be observed through two steps: 1) first step - to determine whether a certain service should be realized through PSO (selection of potential PSO services); 2) second step - due to the limited budget, ranking the services that were selected in the first step as potential PSO services.

In this paper, the algorithm for the first step will be presented, and then, a multicriteria model for ranking PSO services will be developed. After the ranking list of PSO services is formed, and the amount for financing these services is defined, it is possible to present the final list of railway services that will be realized as PSO.

This paper is organized as follows. After the Introduction, in Section 2, the algorithm for potential PSO services in rail transport in Serbia is presented. In Section 3, the MCDM model for PSO services ranking in rail sector is developed. The last Section presents conclusions and future research directions.

2. ALGORITHM FOR PSO SERVICE SELECTION IN RAILWAY TRANSPORT

From the point of view of the community (Law on

Railways, Article 111), the criteria on the basis of which the PSO should be determined are defined. Those are:

- The existence of common interest,
- Availability of other transportation modes,
- Costs of replacing railway transport with another transport mode and
- Qualitative and quantitative potential of railway undertakers.

The existence of a common interest is defined on the basis of travel generation. Travel generation involves determining the scope of travel that begins or ends in the observed zone, city or region, depending on the set of residential, economic and/or socio-economic characteristics of the observed zone [1].

In order to determine the existence of a common interest in more detail for certain trips, it is necessary to perform a travel distribution. Since in the previous step the number of trips that each zone emits or attracts on the observed lines was determined, it is now necessary to determine the passenger flow between pairs of zones (regions), ie between sources and destinations. The table defined in this way is called the O-D matrix. Growth factor models or gravitational models are most often used to define the O-D matrix.

In the next step, it is necessary to determine the availability of other modes of transport. When researching services and lines in railway traffic, first of all, the availability of road transport, as a competitive transport mode, should be investigated. This refers to the research of the availability of both public road transport, as well as the availability of private

¹ Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, Belgrade, d.macura@sf.bg.ac.rs

² Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, Belgrade, p.jovanovic@sf.bg.ac.rs

passenger cars and the possibility of their use.

If the previous step determined that there is a choice between several modes of transport, in the next step it is necessary to perform travel distribution by mode of transport. Models that predict the distribution between types are often called modal-split models and are used to allocate the total number of trips, across all pairs of the O-D matrix, to all available transport modes.

The calculation of the cost of replacing the railway transport with another transport mode should provide an answer to what extent is justified to maintain the PSO on railway instead of switching to alternative modes of transport. It should be kept in mind that the result of this analysis does not have to be explicit, but it is necessary to consider different scenarios, when abandonment of railway transport is fully financially justified, and when it is only partially justified or not at all.

Finally, it is necessary to determine whether the railway undertaking is able to meet the requirements of the requested service. It is necessary to determine whether the operator has a sufficient number of vehicles of the required type, as well as the required number of staff with the required qualifications, to be able to meet the PSO, in terms of frequency and quality of transport on the required lines. If the PSO were awarded by tendering, this step would be redundant, assuming that only the applications of those operators that could meet all the requirements would be considered correct applications.

In order to provide a safe and attractive service, with maximum quality, and increase the share of railways in passenger traffic, and with a limited budget to finance PSO railway services, it is necessary to select PSO services for financing and implementation.

Figure 1 shows the algorithm for determining the justification of PSO service request for the specified transport service in rail passenger transport.

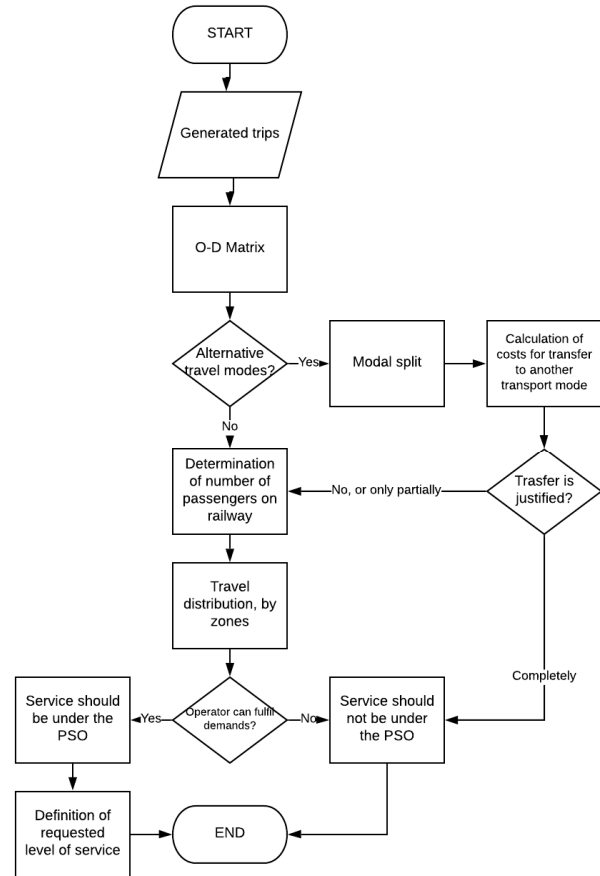


Fig. 1. Algorithm for determining the justification of PSO service request

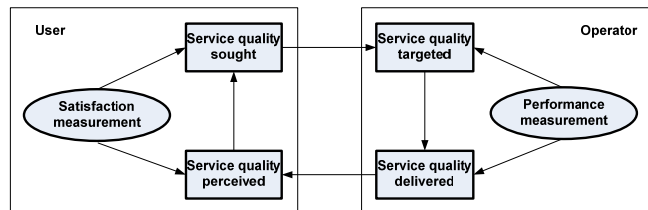


Fig. 2. Service quality loop (source: EN13816)

For efficient and effective service provision, it is necessary to apply the service production according to marketing business orientation - research the market first, i.e. research the needs and expectations of users, and only then produce services that are consistent with the research results. This approach reduces or even eliminates the divergence between the realized or obtained quality and the required quality. Consequently, the satisfaction index of users is maximal. The smaller the divergence between the obtained and required quality, the greater the degree of satisfaction, and vice versa, the greater the difference, the smaller the satisfaction.

In accordance with the European standard EN13816 and the concept of service production according to marketing business orientation, a multi-criteria model for ranking OJP trains has been proposed.

3.2 MCDM model for ranking rail PSO services

For selection of the rail PSO services with a constraint of limited budget, authors developed Multi-criteria decision making (MCDM) model. MCDM approach is proposed since there are heterogeneous and conflicting criteria in the model. The authors proposed TOPSIS method. Hwang and Yoon developed TOPSIS (*Technique for Order of Preference by Similarity to Ideal Solution*) in 1981 [3].

TOPSIS has numerous advantages, such as:

- Traditional and widely used method
- Easy to understand and apply
- Ability to analyze numerous alternatives (no limit)
- Ability to analyze different type of criteria (cost or benefit type)

However, due to the lack of real data, authors will present only elements of the model in this paper, without equations and calculations. The researchers or decision makers in their own research/analyze can apply any MCDM method or approach, not only TOPSIS.

Alternatives in the model are the potential rail PSO services. For each alternative (each PSO train) is necessary to define values of proposed **criteria** (criteria are the performances of a rail service).

In the Table 1 7 criteria are given. Each criterion should have its own weight: $w_i, i=1, \dots, 7, \sum_{i=1}^7 w_i = 1$. Decision maker defines the criteria weights. For PSO services the decision maker is a ministry in charge, in our country Ministry of construction, transport and infrastructure.

Performance measurement and passengers' satisfaction with rail services need to be carried out, and European standard EN 13816 provides the recommendations related to the suitable approaches for this kind of measurements and which quality attributes of public transport services should be considered.

The values of criteria listed in Table 1, railway operator should prepare and forward to the ministry in charge. In Serbia, that is "Srbija Voz" as the only railway company registered for passenger transport.

The values of sub-criteria, i.e. quality attributes of rail service, relevant for the satisfaction index measurement (Table 2), should be defined after the survey conduction. The respondents are rail passengers, i.e. actual users of rail services in Serbia.

After the survey, all data should be analyzed and the final satisfaction index with certain rail service can be measured. This output – the satisfaction index, is one of the 7 input, in fact the last criterion, in the MCDM model.

European Commission (EC) conducted a survey "European's satisfaction with rail services" in 2013 and 2018 [4]. In accordance with European standard EN 13816 and this EC survey, the quality attributes of rail

service are proposed (Table 2). In developed model, the last criterion K_7 is the satisfaction index, and it can be defined based on those selected relevant quality attributes of rail service.

Tab.1. Model criteria

No.	Criteria	Unit	Type
K ₁	Transportation costs	RSD	Min
K ₂	Number of passengers during the last 5 years	/	Max
K ₃	Growth of passenger demand (changes in the number of passengers during the last 5 years)	%	Max
K ₄	The dominant reason for the trip	1-5*	Max
K ₅	Is there some other mode of transport on the route?	1-4**	Min
K ₆	Number of complaints for the rail service during the last year	/	Min
K ₇	Satisfaction index	0-1	Max

*5-work and school; 4-business trip; 3-touristic; 2-leisure activities; 1-other.

**1-no other mode of transport; 2-there is other mode of transport, but rail is better solution; 3- there is other mode of transport, and rail is not so good solution; 4-there is other mode of transport, and it is much better than rail.

The output of the TOPSIS method are relative importances for each alternative. Based on these values, but with a limited budget, the set of chosen alternatives should be defined so the sum of relative alternatives' importances is the maximum. This can be done relatively easy with Excel Solver.

Tab. 2. Quality attributes of rail service

No.	Sub-criteria
K _{7.1}	Punctuality and reliability
K _{7.2}	Frequency of trains
K _{7.3}	Safety
K _{7.4}	Helpfulness and attitude of the staff on board the train
K _{7.5}	Cleanliness
K _{7.6}	Easy connection with other modes of transport
K _{7.7}	Availability of information about the train (especially about train delays)
K _{7.8}	Availability of information in the train (during the travel), especially about train delays

4. CONCLUSION

This paper presents the process of defining the final list of railway services that could be requested as PSO. This process is presented through two steps: selection of PSO services and ranking of PSO services. Railway services that meet all requests for PSO are entering the ranking process. After the ranking, list of PSO services has been made, and the final set of PSO services can be defined in accordance with the budget limitations.

The presented model is useful for a decision maker who should select the rail PSO service when the budget is limited. Decision maker is the ministry in charge, i.e. Ministry of construction, transport and infrastructure in Serbia.

The further research will be dedicated to the development the MCDM model for rail PSO services

ranking in the presence of uncertainty and imprecision in the data.

REFERENCES

- [1] Railway reform : Toolkit for improving rail sector performance, World Bank Group, Washington, D.C., USA, 2017.
- [2] "Transportation – Logistics and services – Public passenger transport – Service quality definition, targeting and measurement", European standard EN13816:2002, European Commission.
- [3] Hwang, C.L., Yoon, K. Multiple Attribute Decision Making: Methods and Applications. Springer-Verlag, Berlin, 1981.
- [4] https://ec.europa.eu/transport/modes/rail/news/2018-09-18-eurobarometer-rail-satisfaction-europeans-increasingly-satisfied_en