KRATKO PRETHODNO SAOPŠTENJE / SHORT OR PRELIMINARY REPORT

MODELING CRITERIA FOR SERVICES OF GENERAL INTEREST ORGANIZED BY TRAIN OPERATORS

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Abstract: *The definition and conclusion of the Public service obligation contract for rail (PSO contract) is between the national passenger railway carrier and the competent transport Ministry. The PSO contract represents an optimal mode of transport arrangement as a unified and unique traffic model with traffic criteria such as timetable, type of vehicle, quality requirements, user behaviour and expected revenues. To conclude a PSO contract, it is necessary to provide a methodology for modelling criteria for transport services of general interest respectively for making the role of a train operator sustainable and satisfying for public needs. AHP method was used for criteria valuation among twenty experts. Encouraging rail passengers transport based on users' requirements leads to a different way of conducting business operations for the carrier. Research results based on experts' opinions shows that most important sub-criteria for providing quality transport service is a state of infrastructure while evaluating timetable parameters. To keep the service on a satisfactory level, experts consider that diesel train costs and maintenance costs needs to be reduced. Experts also concluded that quality requirements sub-criteria such as availability and safety should be provided before and during the journey. Offering numerous and useful amenities at stations such as bars, kiosks and ticket offices will help to retain service users. Last and the most important expert's opinion conclusion is that public passenger transport is depending on state funds and budget. The current practice of awarding PSO contracts is based solely on the scoring of tenders received through published tenders and therefore requires a model that will include all relevant parameters and their corresponding sub-criteria.*

Keywords: *railway passenger transport, PSO contract, transport service criteria, service quality, AHP approach*

JEL Classification: *R42*

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INTRODUCTION

Public passenger transport throughout Europe is carried out in different ways and requires a unified methodology to facilitate the performance of the existing services and to promote new services with a view to improve mobility of citizens. Of all means of transport, rail is the least explored, although it is overly reliant on state subsidies. Since a unique transport model, based thereupon the creating of PSO (public railway and road services, i.e. Public Service Obligation) is possible, does not exist, the need has arisen for specific guidelines and parameters, which should be considered when setting up such contract. A rail transport operator needs a contract, which would define the provision of passenger transport services of general economic interest and obligation to reimburse passengers for loss, as a difference between actual revenue and costs of rail passenger transport in a specific period, with disbursement of state budget funds for passenger transport services provided. Upon conclusion of PSO, certain criteria should be considered such as timetable, costs of timetable implementation, type of vehicle, vehicle funding (procurement and maintenance), quality requirements, influence of customer behaviour and expected revenue.

The purpose of the study is to determine and to model the criteria of services of general interest organized by rail operator, which are based on the applicability of the PSO contract. In order to achieve this, it is necessary to survey the demand market, scientific literature and results of applicability of the PSO contract in other modes of transport. The proposed study hypotheses are as follows:
- technological criteria affect the quality of service of general interest
- user requirements and behaviour affect the quality of service of general interest
- the amount of subsidy affects the quality of service of general interest

A review of previous studies, explained in the second chapter of the paper, determines the role of railway undertakings in terms of the economy resp. the provision of railway transport services in the manner that best suits the needs of the public. The third chapter discusses the study methodology resp. the mode of collection of the necessary data, conducting of surveys with experts and compilation of surveys. The fourth chapter deals with criteria using the AHP approach. The results of the study are presented in Chapter V, where all the criteria are evaluated in accordance with the experts' opinions. The results or values obtained for each sub-criterion may affect the award of contracts on services of general interest. Chapter VI makes concluding remarks based on the results obtained, by means thereof the established hypotheses were substantiated.

LITERATURE REVIEW

By means of a comparative analysis related to the implementation of contract on services in air transport within EU, the study (Williams, Pagliari, 2004) compares differences between various countries resp. member states in terms of acceptance and implementation of PSO mechanisms in air transport. Type of airplane, length of route, traffic volume and local circumstances considerably affect operating costs. It is also important to consider cost estimation per one flight classified as PSO route and identification of strategic lines (European Commission, 2005). Market liberalization can encourage the increase in passenger boarding factors and thus reduce empty aircraft capacity in the summer months due to a large number of tourists, whereas a lower frequency of flights is expected in the winter months (Di Francesco, Pagliari, 2014). Responsibility for tenders, when concluding co-financing contracts in air and sea transport in Greece, belongs to the Ministry of Development, Infrastructure and Transport and the Hellenic Civil Aviation Authority (HCAA). The study deals with maritime and air services that have a more developed model of co-financing contracts than an incomplete and undeveloped contract model in railway transport (Christofas, Papadimitriou, 2013). By measuring the quality of service for passengers at the Hellenic Railways Organization (OSE), a development framework was presented that helps railway undertakings to monitor and to control the quality of service they provide to customers (Nathanail, 2008). Social costs on routes covered by PSO contracts and the calculation of subsidies for regional flights in Norway imply an estimate of costs per flight, which is classified as a PSO route. The aim is to estimate the systematic evaluation, revenues, costs and profit/loss per flight. The Ministry of Transport covers losses to carriers incurred during tenders and contract awarding (Bubalo, 2012). The models of public tender for bus transportation in London and France appear in two distinct methods of tendering. In both models, the organization of public services is the responsibility of local authorities rather than centrally planned. Two different strategies are clearly visible (Saussier, Yvrande-Billon, 2009). The railway reform process is considered a step towards the improvement of the transport service when the State assumes responsibility for the infrastructure part of the railway and the carriers compete to provide transportation services (Alexandersson, Rigas, 2013). Liberalization, privatization and globalization of economy have brought competitiveness to the railway market. The liberalization of railway market encourages the development of private enterprises, their entry into the railway market and competitiveness. Simultaneously, the need for the State to co-finance part of the services is reduced (Kalayci , 2016). The implementation of the reforms laid down by Regulation 1370/2007 is the responsibility of the relevant Ministry of Transport or

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regulatory agency, which requires a study of the results of the process of selection of the appropriate competent authority for concluding a public service contract (Rosić, Bošković, 2013). Local passenger transport in Lithuania generates losses. In almost all EU countries, however, losses are compensated from the national budget. By implementing public services, it is necessary to ensure that the financing of local passenger transport losses does not take place (Butkevičius , 2009). According to the European Commission policy, it is necessary to introduce competition in the railway sector and to open up the market (Johnson, Nash, 2012). Journeys on shorter distances (up to 100km) should meet the requirements of users such as journey time, regularity, timetable frequency, as well as cleanliness of railway stations and vehicles, whereas for passengers on longer distances, in addition to the above factors, the emphasis is placed on comfort and willingness to pay a higher price for the service provided (Fröidh, Byström , 2013).When exploring competitiveness within railway passenger transport, the emphasis was placed on efficiency assessment criteria in terms of performance of a specific service. Passenger transport is one of the main branches of national economy, which wishes to satisfy social needs of passengers in urban and regional areas (Lodi et al., 2016). The abolition of subsidies primarily relates to inability to finance unprofitable routes and failure to approve substitute transport by buses unless the terms of transport are not satisfied. To comply with all these terms, a detailed study is required before reaching final decisions. Part of that study primarily implies the determination of the exact local routes, which satisfy passengers' needs. Based thereon, the criteria are determined, whose fulfilment guarantees successful transport service and optimal price and transport service quality ratio.

STUDY METHODOLOGY

According to Regulation (EC) No 1370/2007, public service in rail passenger transport is to be carried out in a transparent and generally approved manner. By concluding a Financial agreement, a client is obliged to cover the actual difference between costs and revenue incurred during the provision of public service. For this purpose, a methodology needs to be developed, based thereon this would be regulated. The methodology, i.e. mathematical model would be based on present and future costs resp. revenue and expenditure, which partly depend on European market prices and economic situation in the country. It is possible to define and classify public service, which the transport company is providing, both as their expenses and profit they have achieved with their own capacities. By determining the impact of available capacity, i.e. rolling stock that the company

has available, the level of subsidy required for improvement of public services is determined, since the company's revenue/expenditure ratio is not sufficient for service improvement and sustainable company development. The acceptable rolling stock structure reduces the operator's operating costs and improves public service quality. At the same time, it reduces the client's obligations for public service cost coverage. Apart from mandatory provisions of Regulation 1370/2007, that the train operator is subject to and according to legislation in force, it is necessary to adopt other European regulations and directives that might help train operators achieve the European level of service and become adjusted to market liberalization. To this end, it is necessary to have a sustainable technological and economic approach, defined by methodology for establishing costs in different segments of public passenger transport service.

Previous scientific and research activities were primarily directed towards criteria determination, especially transport criteria, which are required for methodology and designing PSO Contract model (Vesković et al., 2016).

Criteria determination structure and methodology with the objective of designing PSO contract model are shown in Figure 1.
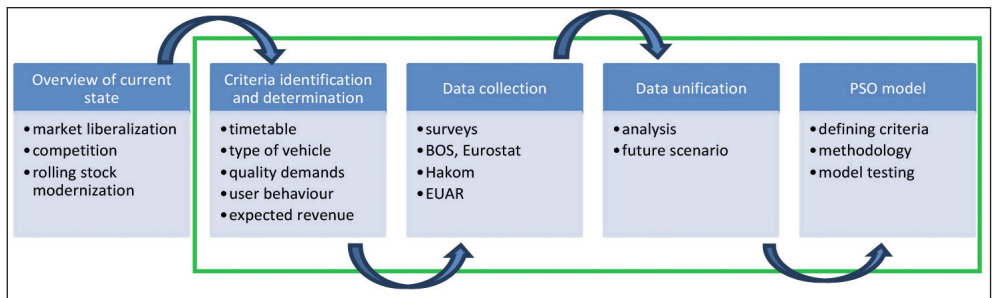

Figure 1. Phases and methodology for criteria determination

Source: authors

Determination of criteria significance for description of railway transport quality through AHP approach is the evaluation of weight criteria made by experts. It is necessary to determine significance gained by applying the decision supporting system. The method of pairwise comparison, developed by Thomas L. Saaty, was selected for marking railway transport quality. Methods for determination of weight criteria, which can be used for describing railway transport quality, are considered subjective when valuated by respondents or experts. In that case,

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the experts' expertise should be high because it depends on their evaluation. For this purpose, criteria comparison was made pairwise, as suggested by Saaty (1980) and is known as AHP method (Saaty, Vargas, 2012) (Coyle, 2004). This approach enables determination of criteria weight of the same hierarchy level regarding higher criteria level or defining hierarchically unstructured weight criteria. Experts are comparing all R_i and R_j criteria ranks ($i,j = 1, ..., n$), where n is the number of criteria comparisons. The application of the AHP requires a very developed logical reasoning. The assessment of a highly qualified expert can be more important than the evaluation made by numerous inexperienced experts, who didn't use logical reasoning.

Service quality parameters are to be defined in a manner that they take specific passenger needs into consideration. The selection of quality parameters is based on the European standard EN 13816 (CEN, 2002). Quality parameters are defined by (CEN, 2002), (Van de Velde et al., 2010) and they are accuracy – component of the quality of results, frequency, cleanliness, proper functioning of technical facilities on vehicles, passenger information, on board services, and handling customers complaints.

MODELING CRITERIA BY APPLYING THE AHP METHOD

From the point of view of transport realization, transport service quality – in terms of logistics – can vary in several ways according to: timetable and operation frequency, operation speed and number of stops, vehicle characteristics, particularly comfort and capacity, tariff and tariff structure, additional services on board vehicles.

Development of railway transport is undoubtedly a demanding task in terms of economy. Since it is, however, ecologically the most appropriate means of transport, this means it is also a key economic driver. The development of transport system needs to be standardized, transport sector performance controlled, noise level emitted from vehicles reduced or eliminated. Efficient railway transport services largely depend on starting point of service (terminals), optimization of vehicle characteristics, minimal losses due to delays and excessive power consumption as well as employment of the required rolling stock. Rail journeys need to be safe and comfortable. It is only then that railway will be able to attract more passengers and become competitive in transport market. It is crucial to define passenger needs as well as evaluation methods and methods for improving transport service quality, defined within a wide range by criteria, which can be

influenced by local government and transport operator (UITP Position Paper, January 2003).

A study was conducted with the support of HŽ Passenger Transport Ltd. (HŽPP) and the following criteria were taken into consideration:
1. timetable,
2. type of vehicle,
3. quality requirements,
4. customer behaviour, and
5. expected revenue.

The analysis is based on the application of the AHP method. Criteria describing transport service were gathered from surveys addressed to experts from HŽPP company. Transport service chart is divided into five groups of criteria and their associated subcategories (Figure 2). A survey was conducted in September 2018.
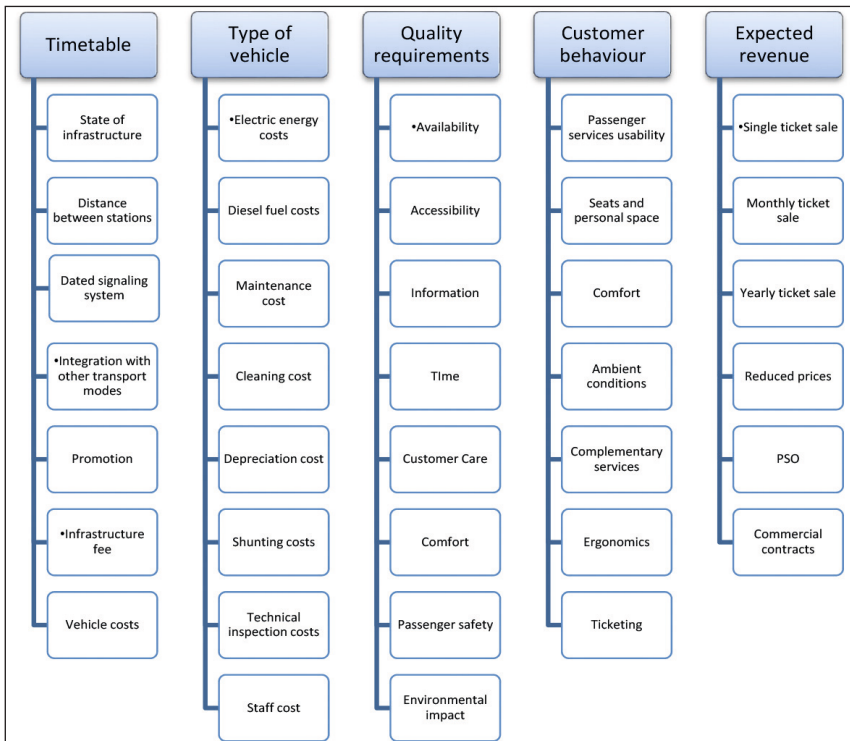

Figure 2. Transport Service Criteria

Source: authors

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For study purposes, the evaluation of criteria from 20 experts was taken into account. Experts were selected based on their experience, qualifications, expertise and knowledge from various divisions such as sales division, logistics division, corporate affairs, finance and operations. The application of AHP method requires a highly developed logical reasoning. The evaluation of a highly qualified expert particularly may be more important than the evaluation made by numerous inexperienced specialists. To fully grasp the problem, we intend to solve, it is necessary to know the domain, where the problem lies.

For the purpose of this study, the most important thing to do was to compare a special criterion with another, because pairwise criteria comparison is much simpler than comparison of all criteria at the same time, (Kendall, Gibbons, 1990), (Montgomery, 2007), (Chen, Hung, 2016), (Sivilevičius, Maskeliūnaitė, 2018). The experts made a comparison of all evaluated a_i and a_j criteria ($i,j = 1, ..., n$), where n represents the number of criteria compared.

A pairwise evaluation criteria comparison matrix ($a_{ij} = \frac{1}{a_{ij}}$) is as follows:

$$A = \begin{bmatrix} 1 & a_{12} & a_{13} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & a_{23} & \cdots & a_{2n} \\ \frac{1}{a_{13}} & \frac{1}{a_{23}} & 1 & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \frac{1}{a_{3n}} & \cdots & 1 \end{bmatrix}$$ [1]

To unify railway transport criteria previously mentioned we show in Table 1 pairwise comparison of one of criteria (timetable).

Table 1. Ranking weight criteria factors example according to Saaty's scale

Criteria	No. of criteria	K1	K2	K3	K4	K5	K6
State of infrastructure	K1	1	7	5	9	5	3
Distance between stations	K2	1/7	1	1/5	3	1/3	1/5
Integration with other transport modes	K3	1/5	5	1	5	3	1/3
Promotion	K4	1/9	1/3	1/5	1	1/5	1/7
Infrastructure fee	K5	1/5	3	1/3	5	1	1/3
Vehicle costs	K6	1/3	5	3	7	3	1

Source: authors

In Table 1 number on position (line K1, column K4) is 9. It reflects the decision maker's attitude that criteria K1 is extremely more important than K4, i.e. the state of infrastructure is much more important than promotion in order to have an efficient and operational timetable. By making this statement, the value at position (line K1, column K4) is known due to the fact that K1:K4=9:1 makes K4:K1=1/9. Based on similar arguments, it can be concluded that values 1 should be on the strut and that matrix is diagonally reciprocal, i.e. it can be applied:

$$a_{i,j} = \frac{1}{a_{i,j}} \ for \ i,j \leq n \qquad [2]$$

where n is the number of comparative alternatives.

To obtain the average weight, it is necessary to divide each table value by column sum. Consequently, the average value per line can be calculated. The values obtained as the average are relative weights of individual criteria. To check a pairwise consistency comparison, the approximative value of specific value of reciprocity matrix was calculated. Each comparison matrix value is to be multiplied by column weight criteria. Accordingly, value sums per lines are calculated:

$$1 * 0.44047 + 7 * 0.05097 + 5 * 0.15172 + 9 * 0.02832 + 5 * 0.09808 + 3 * 0.23044 = 2.99245 \qquad [3]$$

The value obtained is divided by weight criteria for a line. The estimated (approximative) value for the line is thus obtained:

$$\frac{2.99245}{0.44047} = 6.79377 \qquad [4]$$

To provide a unique evaluation, it is necessary to calculate the average evaluation of characteristic values (eigenvalue):

$$\frac{6.79377 + 6.04199 + 6.63927 + 6.25556 + 6.19932 + 6.85531}{6} = 6.46420 \qquad [5]$$

Respectively, eigenvalue is λmax = 6.46420. The essential requirement when establishing eigenvalues is that the largest eigenvalue of symmetrically inverse n-row matrix with n number of rows must be $\lambda max \geq n$. It is necessary to check whether the condition has been satisfied. In the case considered, the matrix row

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or size is n=6; therefore 6.46420 > 6. The condition is satisfied.

Next step is establishing consistency index (CI):

$$CI = \frac{(\lambda max - n)}{(n-1)}$$ [6]

where λmax is eigenvalue and *n* the number of criteria or alternatives.

$$CI = \frac{(\lambda max - n)}{(n-1)} = \frac{(6.46420 - 6)}{(6-1)} = 0.09284$$ [7]

The lower the CI value, the higher inconsistency of the matrix. The value obtained is compared to the Random Index (RI) and the values are given in Table 2.

Table 2. Saaty's Table

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49

Source: (Barić, 2010), (Hunjak, Jakovčević, 2003).

The relationship between the consistency index of the matrix CI and the average value of the random index RI, indicated as per Table 2 is referred to as the Consistency Ratio (CR) that represent degree of matrix consistency.

To establish whether the comparison has been consistent, it is necessary to determine the inconsistency ratio, i.e. the ratio of inconsistency index and random inconsistency coefficient:

$$CR = \frac{CI}{RI} CR = \frac{CI}{RI}$$ [8]

The matrix is considered to be consistent if the value of CR is smaller than or equal to 0.1. Since 0.07427 < 0.1, the considered matrix is consistent.

To obtain a total opinion from all 20 respondents, it was necessary to use geometric mean from all 20 weight criteria. To obtain the average weight, it is necessary to divide each table value by column sum which gives result in amount of 0,41886. Based on the same principle of sub-criteria comparison, the results for the remaining transport criteria required for creating a unified PSO Contract were obtained. Their values are assessed and shown in Figure 3, 4, 5, 6 and 7, according to experts' logical conclusion.

RESULTS AND DISCUSSION

Timetable (Figure 3) is certainly one of most important criteria. With its relevance, it affects the unified model of PSO Contract because of the time spent on journey, i.e. the shorter journey time is, the more satisfied passengers are, and railway operator will win a regular customer. By comparing all timetable sub-criteria, the state of infrastructure, which includes permanent way and substructure of the track, number of tracks, signalling system, etc., is considered one of the most important sub-criteria for providing passengers with a quality transport service, according to experts' opinion. The average weight criteria sum for this sub-criterion amounts to 0.41886, which shows that state of infrastructure is far more important than other sub-criteria, which substantiates the hypothesis as to the importance of technological criteria and their impact on the quality of service of general interest. According to experts' opinion, distance from station, integration with other transport modes, promotion, infrastructure fee and vehicle costs are equally important and valued with average sizes from 0.05507 – 0.16702.
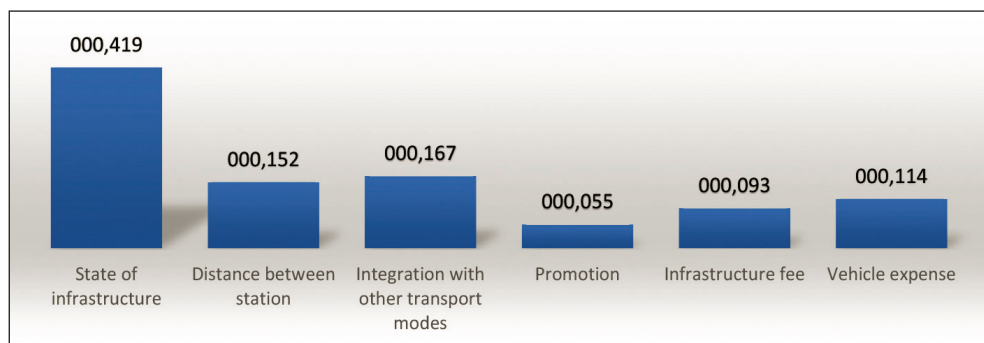

Figure 3. Timetable

Source: authors

While evaluating criteria – Type of vehicle (Figure 4) – experts were required to evaluate the costs, based on their knowledge and experience, as to what type of vehicle is most economical for providing transport service. While evaluating this criterion, it was necessary to consider several prerequisites as follows:

1. EMUs and DMUs are consuming less fuel than the conventional train composition pulled by locomotive.
2. EMUs and DMUs don't require shunting and technical inspection of coaches; this cost is, therefore, not included in this case.

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The average sum of weight criteria for sub-criteria – Maintenance cost – related mainly to diesel locomotives and railcars amounts to 0.22225. Besides diesel fuel cost, it is the most significant cost for transport operator, according to experts' opinion. Electric energy cost is twice cheaper than diesel fuel cost. It can thus be concluded that the use of EMUs is most efficient and viable for transport operator. Maintenance costs, shunting costs and costs of technical inspection of railcars as well as rail staff costs can be reduced through increased exploitation of EMUs. Rail staff costs are in the high third place, which is raising concerns. This is an indicator, which should be influenced and reduced because it largely affects the value of PSO Contract.
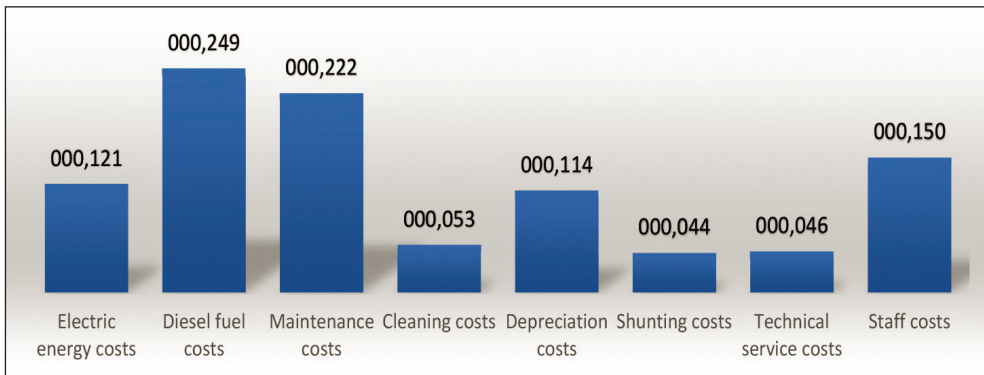

Figure 4. Type of vehicle

Source: authors

Quality characteristics (Figure 5) such as availability, accessibility, information, time, customer care, comfortability, passenger safety and environmental impact, are selected as sub-criteria based on the European standard EN 13816 (CEN, 2002). Railway experts had a task to decide as to which sub-criteria, according to their opinion, is most important to passengers, i.e. transport service users in order for them to be satisfied with service provided. They have decided that the most important sub-criterion is availability of service, which they evaluated with 0.22037. This is due to the fact that availability implies distance between place of residence and transport vehicle entry/exit point, need for less and shorter transfer from one mode of transport to another as well as rail network distribution. Passenger safety is marked as the second important criterion, with a slightly lower rating. Journey time, i.e. timetable accuracy with the average sum of weight criteria, amounting to 0.16034, takes third place.
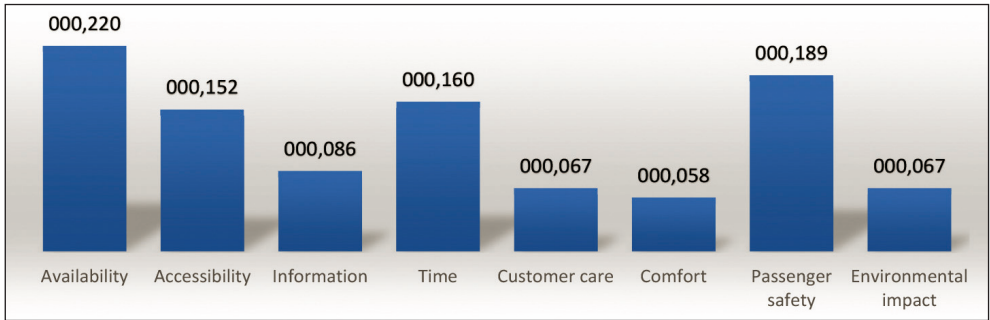
Figure 5. Quality requirements

Source: authors

User behaviour is described in Figure 6. These characteristics include passenger services usability, seats and personal space, comfort during ride, ambient conditions, complementary services, ergonomics, and ticketing. Service quality level, required from users, affects the quality of service. To retain regular passengers, transport operator, according to experts' opinion, needs to pay the greatest attention to passenger amenities usage at entry and exit points of vehicle as well as on board vehicle during the journey. Other aspects, which need to be taken into consideration, are comfort, seats and personal space as well as ticket issuing option. According to experts' opinion, these are the most important qualitative characteristics that service provider should influence to raise the level of transport service quality so that it can reach a satisfying level, which users are expecting. This proves the importance of the impact of the hypothesis "User requirements and behaviour affect the quality of service of general interest "on the whole transport service. Passengers perception is focused on delivered quality and it depends on their personal experience of that service or related services.
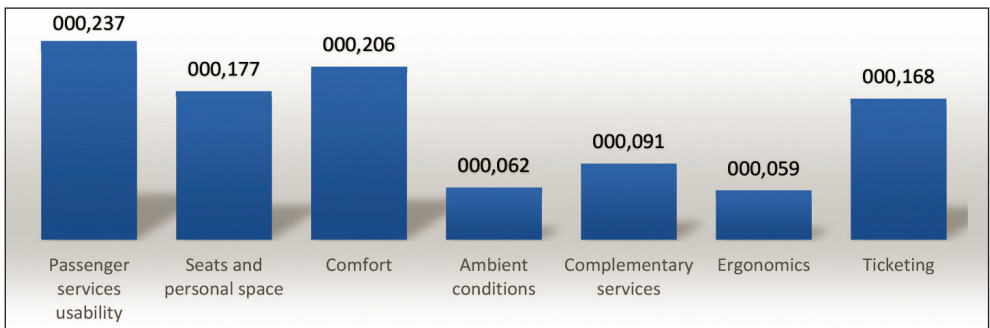

Figure 6. User behaviour

Source: authors

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Experts' opinions regarding expected revenue is showed in Figure 7. According to their evaluation, public service contracts are considered crucial for a successful transport service. The amount of subsidies, which was assessed by experts at a high 0.31056, substantiates the hypothesis that the amount of subsidy affects the quality of service of general interest. The higher the amount of the subsidy, the greater business opportunities for the carrier in providing the transport service to its customers. Contracts need to be concluded between a national body and local or regional self-government through the mediation of a transport provider. In order for the operator to be as much acceptable and competitive as possible, while tendering public services, his business has to aspire towards profitability. This can be achieved by introducing additional sales and marketing activities, which would need to have results such as sales increase, primarily in terms of monthly and annual tickets.
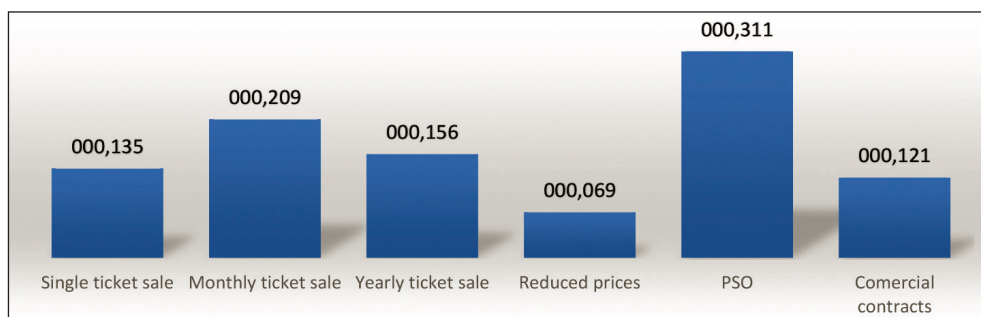

Figure 7. Expected revenue

Source: authors

CONCLUSION

Based on the study conducted among 20 experts, the criteria of PSO Contract elements and transport service quality were evaluated accordingly and divided into five categories such as timetable, type of vehicle, quality requirements, customer behaviour and expected revenue. Each group had a fixed number of sub-criteria required to make qualitative analysis of the basic criterion. According to Saaty's scale, each sub-criterion was allocated a certain weight factor, by which local criteria weight was defined. Subsequently, based on local criteria weight, the total criteria weight was determined. Evaluated relevance criteria, provided by experts within a survey, are consistent due to calculated consistency ratio. A consistency ratio, calculated by experts, was within given framework, i.e. lower than 0.1. A very high level of experts' consistency in terms of feedback was based on their expertise, knowledge and experience and is considered relevant

as such. Experts' opinion on timetable was that the state of infrastructure was one of the most important sub-criteria for providing quality transport service. Likewise, in order for the service to be at satisfactory level, experts believe that it is necessary to influence factors such as diesel train costs and maintenance. With greater usage of EMUs, maintenance costs, shunting costs and cost of technical inspection of railcars will be reduced. Public services, provided by the company, can be defined and classified in terms of both their costs and profit achieved with their own resources. By determining the impact of available capacity resp. rolling stock that the company owns, the level of subsidy required for public service enhancement is determined. This is due to the fact that the company's revenue and expenditure ratio is not sufficient for service improvement and sustainable development of the company. The appropriate rolling stock structure reduces operational costs of service provider, improves public service quality and reduces contractors' obligations for public service cost coverage. While evaluating quality requirements sub-criteria, the experts believe that – to provide a quality transport service to users – availability and safety prior to and during the journey should be provided. To retain regular service users, it is necessary, according to experts' opinion, to offer numerous and useful amenities at stations, stops and transfer places. Considering that public passenger transport is largely depending on state funds and budget, evaluate public service contracts as key to sustainable transport service. Conducting and monitoring of PSO is possible by means of basic qualitative and quantitative indicators such as availability, safety, comfort, reliability, customer satisfaction with service, information, promotional campaign, etc., followed by sustainability indicators and financial calculations of monthly costs, by means thereof PSO is justifying its existence and facilitating existence of railway operator in the market. Through harmonization of European and national legislation, it is possible to positively influence decision makers in terms of accepting the model shown with the objective of enhancing citizens' mobility and railway transport system.

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