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HOW TO DESIGN TRACK ACCESS CHARGES FOR SMALL RAILWAYS – A MONTENEGRO CASE STUDY

ABSTRACT

In 1991, the European Union decided on setting up a liberalized and single railway market. However, in the atomized European region, more than a half of railways can be designated as small railways. For the very reason of significant differences between the national railway systems, the EU legislation has laid broad grounds for track access charge (TAC) modelling, thus resulting in many different TAC models. Out of numerous papers in respect of TAC modelling, only a small number consider the specificities and the needs of small railways. The paper aims to answer the questions of how to design or set up an efficient TAC structure when it comes to small countries. Another objective is to answer how to develop a TAC structure allowing the infrastructure manager to manage its costs. The answers to these questions are provided through the case study of railway in Montenegro – small railways in the Western Balkans. The main contribution of this paper is on developing the TAC model based on the efficient ratio of the capacity and infrastructure wear and tear components.

KEYWORDS

track access charges; efficiency; model design; small railways; case study; Montenegro.

1. INTRODUCTION

In the last decade of the 20th century, the European Union (EU) opted for the development of railway network competition aiming to achieve a competitive and efficient railway transport. After more than a century, the concept of natural monopoly as a doctrine in regulating national railway systems was abandoned. The final aim of introduced structural changes was to create a Single European Railway Area (SERA) with the market competition between train operating companies. This year marks the 30th anniversary of publishing of the Directive 91/440/EEC whereby the railway market development process was initiated. Throughout this period, the EU has published four legislative packages for railways (2001, 2004, 2007 and 2016), each of them representing an important step forward towards achieving the set goal.

Introduction of competition to railway infrastructure has, in addition to restructuring of incumbents, also required setting up new bodies for regulating the railway safety and market. The emergence of a market requires the introduction of new instruments for market regulation that did not exist in the monopoly era. One of these instruments are track access charges (TAC).

The Directive on the development of the Community's railways 91/440/EEC had laid down the basis for free access to railway network. It was not until the Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges was published in 2001 that the basic rules for setting up the charging system for the use of railway infrastructure were provided However, this Directive, at the time, laid down a very broad legal framework enabling the Member States to create TAC models practically without any limitations. The choice of the economic principle and TAC model as well as the pricing policy were completely entrusted to the Member States and their respective infrastructure managers. It was not until 2015 that first, but small steps, or, more precisely, limitations of the cost coverage and level of TAC were defined by virtue of the Regulation 2015/909/EU on the modalities for the calculation of the cost that is directly incurred as a result of operating the train service. That was also the last document regarding setting the TAC elements published by the EU to date.

It is obvious that setting up the Single European Railway Area and the efficient competition on the network (which will result in a satisfactory level of railway efficiency) has required a longer period than initially thought. The reasons for this lie, among other things, in the heterogeneity and disproportion in the sizes of national railway systems. The diverse historical heritage of railway systems in various European countries has caused slower development of competition, which could be essentially characterized as evolution. This is especially true if we were to consider the time component of this process only. Also, the degree of compliance between the national TAC methodologies and models can be described in this way. Not only are the charging schemes and models for calculation of TAC significantly different by countries, but also the models in the same countries frequently change. Presently it seems that TAC models, both on the national and the European levels, are yet to enter the stable regime zone, i.e. it seems that they are still in the zone of initial development and frequent changes [1].

One of the significant sources of diversity is a large difference between the sizes of national networks or railway systems in the European countries. The European (railway) area is atomized. It comprises a significant number of railways, i.e. countries that can be defined as small. The concept "small" does not only refer to a country's small territory or small population and size of its railways and railway network, but also to the capacities regarding all types of resources required by the railway system. This particularly applies to the development of market and competition on national railway networks. If we look at the map of European countries and the statistical data on their key figures, we will notice that more than a half of European countries have small railways (see *Figure 1*).

It seems that when developing the single railway area and market, the EU has set all the solutions and mechanisms in relation to big countries and systems, i.e. the ones with adequate resources. When it comes to restructuring, market and competition development or TAC systems and models for small railways, there are very few research projects. Furthermore, there are only a small number of academic papers related to researching TACs in small railways. Having in mind all these facts, one of the most important questions that arises is how to approach the designing of a TAC model in case of small railways?

This paper aims to use railways in Montenegro as a case study to present the main dilemmas and formulate the methodological approach to designing TAC models for small railways. More specifically, it is to identify the key dilemmas in defining a TAC model in the context of small railways with a special reference to selection of elements for TAC calculation. The designed model should enable the infrastructure manager to manage its costs in the conditions of its larger independence and liabilities in the open market.

2. BACKGROUND

Given that the TAC model needs to satisfy several objectives, some of which are opposed, it always has to represent, to a greater or lesser extent, their compromise. The objectives and interests in question are the ones of several entities in the railway sector: infrastructure manager, government with the respective ministries, passenger and freight operators. Bearing in mind that environment, the TAC structure needs to ensure a good balance between the financial stability of the infrastructure manager as well as market attractiveness for new operators' entrance and promotion of competition between them [2]. Furthermore, the TAC structure should reflect the infrastructure manager's cost accounting system, as well as market segmentation, network categorization and use of railway network.

The term "TAC structure" is used to denote the elements and the relations between them, i.e. how they are mutually interconnected in the calculation of charges. A review of EU Directives (2001/14/EEC and 2012/34/EU) regarding the requirements for the structure for Minimum Access Package (MAP) has shown that the directives provide the guidelines as to which elements may be comprised by the TAC model, but they do not indicate how these elements are to be combined. A review of Network Statements published on the European infrastructure managers' web sites has shown that every infrastructure manager uses its own formula and different symbols to identify similar elements and parameters.

After the introduction of the separation of the European railways, many authors have researched and evaluated the railway infrastructure charges by way of case studies, such as for Germany [3], the United Kingdom [4], France [5], Netherlands [6], Sweden [7–9], Italy [10], Bulgaria [11] and Austria [12]. The common denominator for all the above studies is that they cover countries with large railway networks, large volumes of traffic, human resources and extensive experience in monitoring and modelling of infrastructure costs. The authors [13–16] mostly dealt with comparative analysis of applied costing principles, access charges structure or level of charges in several countries during the implementation of the first two railway packages. Moreover, the studies were also focused on analysing and applying adopted costing principles and access charges structure in correlation with the environment and the historical background without a detailed critical reflection on the reasons for introducing the specific elements and factors within the charges structure. The International Union of Railways also presents an overview of the European TAC systems and explores railway costing differences among the countries. The results of these studies show that the countries differ in relation to the applied principle of charges and goals, level of cost recovery through charges, charge formulas etc. Finally, the authors point out the heterogeneity of calculation methods as well as different levels of resulting charges.

Even for small and non-complex railways such as Portuguese, Serbian and Croatian railways [17-19], the complexity of railway infrastructure access charging systems and formulas for calculating the level of charges increases with time.

However, all discussions regarding the components in the TAC formula [4, 11, 13, 14, 20, 21] and attempts to propose the charges structure taking into account the elements such as lines with associated infrastructure features (international, main, regional or local lines), wear and tear of infrastructure elements, path reservation, use of electrical supply equipment for traction current, train category etc. are still in the direction of researching a pattern among these elements.

In researching the railway market, certain authors [21, 22] have analysed the unit infrastructure costs as well as the values of particular elements in TAC formulas. They pointed out that an appropriate level of TAC elements is one of the conditions for guaranteeing fair competition in the rail sector.

Where lies the importance of charges structure? By selecting the specific charges structure, the infrastructure manager sends certain quantified signals to the operators in terms of destimulation or incentive for fostering particular activities, traffic operations and selection of rolling stock, as well as behaviours in traffic. The TAC formula always sends a message about whether infrastructure manager is encouraging something (e.g. increasing train weight or length or both), i.e. in what way and how much they value it, or whether it is less important in relation to other factors such as occupation of infrastructure capacity. The selected TAC structure can sometimes serve to prevent or discourage the entry of new operators, or, more precisely, to protect the incumbents' dominant position, as is the case with two-part access charges [23, 24].

Taken as a whole, the selected components, including the weights, coefficients and variables, in the TAC formulas should reflect the allocation of infrastructure costs by category of line, type of traffic (passenger or freight) and market, as well as by type of vehicles and defined services [25].

2.1 TAC structures in practice

TAC structure can be classified in several ways. In this paper we pointed out the two most important classifications that have posed as a dilemma in TAC design for Montenegrin railways.

If we apply the category of costs as the criterion (variable and/or fixes costs), we can differentiate between single- and two-part charges [26]. Considering the number of components, measuring units and their relations, the second criterion for classification is the complexity of charges structure. We can differentiate between four types of TACs [24]:

- simple: when the charges formula contains simple relations between the components and with measures of use: train kilometer or gross tonne kilometer;
- simple +: simple charges with one or several parameters added (e.g. level of infrastructure utilization, train speed), while several measuring units are used for the calculation;
- multiplicative: when the basic part of charges calculation is increased by various multiplicative factors (e.g. factors related to train weight, line category, service category): several measuring units are used for the calculation;
- additive: charging scheme consisting of several parts (addends) whereas each part (addend) can be simple or multiplicative or expressed by another formula type.

The above classified types of charges structures have certain common features. Among the single charges structures we can differentiate between the ones that are based on covering the infrastructure wear and tear costs and the ones that are based on infrastructure capacity costs [20, 25]. The two-part TAC structure does not pose a significant problem to operators with large number of paths, stable demand and long-term planning of operations. However, when it comes to smaller operators specialized for only one market segment and having a smaller number of paths, and in particular, the new operators, regular charging of fixed costs by two-part TACs poses a large burden and risk that is hindering the development of competition.

We would like to highlight that the importance of defining the access charges structure lies in the relative ratio between the components for capacity and the wear and tear in the total TAC amount. This ratio differs significantly by countries. In some countries, for the charges in relation to the wear and tear the coefficients differing based on the train weight (Luxembourg, Greece, Croatia, Poland, Czech Republic) are used, whereas in other countries the train gross weight is multiplied with the unit charge per gross tonne kilometer (Italy, Serbia, Bulgaria, Hungary, Austria, Norway and Switzerland). When it comes to charges in relation to the capacity of railway infrastructure, they are in correlation with the line category and train category.

Figure 1 presents the results for 14 selected infrastructure managers according to their respective 2020/2021 Network Statements. The results are provided for the average freight train of 1,000 tonnes for a route of 400 km on the main lines of the observed small railways. Albania, Moldova and Bosnia and Herzegovina, as small railways, did not publish their respective Network Statements whereas the data for Estonia are not available.

A significantly high share of the capacity component is present in 8 countries. In 4 out of these countries (Croatia, Slovenia, Montenegro and North Macedonia), the infrastructure managers combine the impact of capacities usage and wear and tear in one formula with multiplicative form where the measuring unit for capacity (train km) is combined with the wear and tear coefficient. Thereby, the values of wear and tear coefficients are provided either depending on the train weight with more or less developed scale of train weight intervals or depending on the train type.

Among the observed small railways, five of them have wear and tear as a separate and clearly distinguished component. Their share in the level of access charges for an average freight train significantly varies, from 100% (Lithuania) to 9% (Latvia). One should note that setting the wear and tear coefficient is very complex and requires a more precise allocation and monitoring of costs in the longer period. Furthermore, a more detailed monitoring and recording of a large number of infrastructure performances are required as well as determining their dependence on the traffic volumes [28]. Small railways do not have the professional and financial resources for such studies, hence they determine the wear and tear coefficients mostly based on benchmarking against other railways and/or rough estimates.

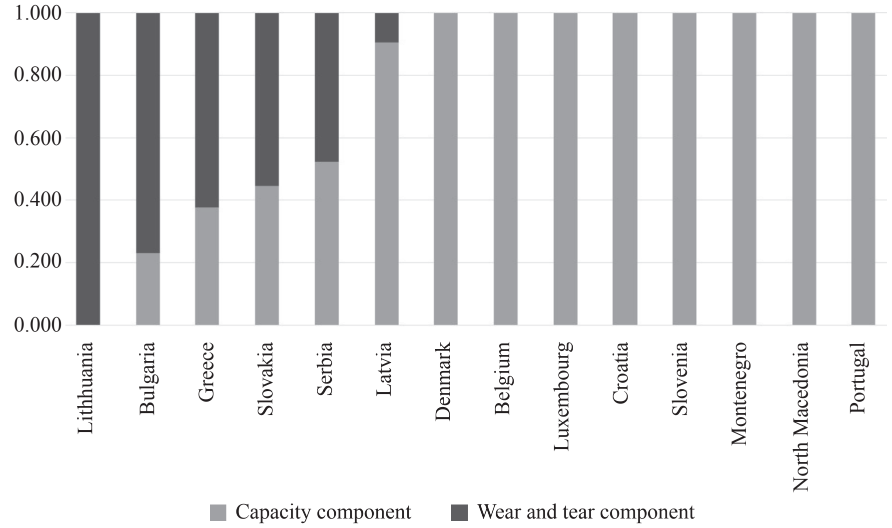

Figure 1 – Percentual share of charges for wear and tear and railway infrastructure capacity by countries [27]

Furthermore, when it comes to TAC structure, the measuring units are another interesting peculiarity. Selection of basic measuring units is in direct correlation with the category of costs to be reflected by the TAC. The gross tonne km is a measuring unit which reflects the infrastructure wear and tear costs, i.e. the variable costs, in the best way. The train km or the number of trains are measuring units that reflect the capacity occupation costs in the best way. Charging based on gross tonne kilometres affects the TAS level for freight trains more, since their weight is greater compared to passenger trains, whereas charging based on train kilometres affects the total TAC level for passenger trains more because they operate more frequently. A TAC based on train kilometres almost always sends a message to freight operators that increasing train weight pays off. And vice versa, having access charges based on gross tonne kilometres in most cases sends a message that forming heavier trains is not an option leading to a reduction of operator costs and is applied in the conditions of low network capacity utilization.

2.2 General formula for TAC calculation

Regardless of the previous classifications and applied criteria, by following the legislative framework, we set up the general formula for calculation of charges for MAP in the following format:

$$C = C_{ad} + C_{op} + C_{wt} + C_{oh} \quad (1)$$

where:

C_{ad} – component representing the administrative costs,

C_{op} – component reflecting the traffic operation costs,

C_{wt} – component reflecting the infrastructure wear and tear costs, and

C_{oh} – component reflecting the use of electric supply equipment for traction current.

In the above provided general formula (*Equation 1*), each component is provided in the form of one addend. Due to the small number of trains in the practice of small railways, the first two components are usually unified into one component which essentially represents the charge for using infrastructure capacities. Additive formulas also contain the coefficients for increasing or reducing components in the structure.

Different selections and combinations of elements in the European railways' TAC structures show that it is very difficult to reconcile all these components. Applying the same economic principle for access charges in the Single European Railway Area, as well as a design of unified and simpler charges structure, will still have to wait. The influencing factors lie primarily in different levels of implemented restructuring processes in individual railways, as well as in the degree of achieved operator competition and market regulation [29–31].

The contribution of this paper is twofold: (1) filling the gap in designing an efficient charges structure when it comes to small railways based on the example of railways in Montenegro and (2) laying the groundwork for developing the charges structure which enable cost management in the conditions of infrastructure manager's higher independence and liability in the open market.

The following Section 3 focuses on a brief overview of the railway sector. Section 4 provides the methodological framework for TAC. The authors describe the new TAC model for small countries based on the case of Montenegro. Section 5 illustrates the results and discussion in relation to the characteristics of ratio between the capacity and the wear and tear components in the TAC structure. Section 6 concludes the article by presenting the future research line.

3. MONTENEGRIN RAILWAY SECTOR

Sometimes, one cannot undoubtedly say for a certain railway that it is small, but when it comes to the size and resources of the state of Montenegro and its railways and railway network, then this is evident. Montenegro has the smallest railways among the former Yugoslavia countries with a route length of 250 km and the smallest traffic volume (around 1 million train kilometres per year). Traffic density is only about one thirteenth of the EU-27 average [1]. Passenger services account for around 67 percent of traffic volume. Given that all passenger services fall under the PSO, this is a very unfavourable ratio between the volumes of passenger and freight traffic. Labour productivity is lower than one tenth of the EU-27 average. A brief overview of Montenegrin railways performances is given in *Table 1*.

The railway network in Montenegro is not part of any official European freight corridors although the final point of the main railway line is the Port of Bar on the Adriatic Sea. However, in terms of its position, the Port of Bar is a local port which is oriented towards Serbia and the poorly developed

*Table 1 – Summary railways performances in Montenegro**

Performance	Total
Land area [km^2]	13,888
Population [citizens]	620,029
Route-length [route-km]	250
Main line capacity [train]	43
Route density [route-km/000sq km]	18.12
Transport volume [pass-km + tonne-km (million)]	(60+169) 229
Traffic volume [pass-train km + freight-train-km]	(693,021+339,122) 1,032,143
Proportion of passenger traffic [percent by traffic volume]	67%
Traffic density [traffic volume / route-km (000)]	4.128
Employees (infrastructure manager and operators) [staff number]	1,411
Productivity [traffic volume / employees (000)]	0.731

** Infilled data for performances are for 2019 (Source: Network Statement, Financial Report, Interior source, Montestat) Only traffic unit data are for 2017 (WB data base)*

Montenegrin industry. The capacity of the railway network is small (*Table 1*) since the main line leading to the port has the performances of a mountain line with very difficult parameters (gradient, curve radii, numerous bridges and tunnels) and it is very demanding in terms of maintenance.

Out of all former Yugoslav countries, railway sector restructuring was performed first in Montenegro and in a relatively short period of time. It was implemented in the period 2005–2014 in three phases [32]. However, no instant effects occurred, primarily due to the absence of restructuring in the Serbian railway sector which represents a link to the European railway network for the railway in Montenegro.

4. METHODOLOGICAL FRAMEWORK

The new TAC model for Montenegro is underpinned by four pillars. The model should (1) fulfil all the requirements of the EU legislation and (2) follow the best practices of the EU railways. Furthermore, (3) the TAC model should include the experiences in the implementation of the previous formula and the gap analysis results and (4) take into consideration the opinions of all the stakeholders obtained in interviews. In such a way, both the impact of the EU directives' implementation as well as the national requirements regarding the development of railway transport and management of infrastructure manager's costs are included and analysed.

4.1 Legislative framework

The TAC legislative framework in Montenegro is identical to the one in the EU. As detailed in Annex II of the Directive 2012/34/EU, the minimum access package shall comprise: (1) handling of requests for railway infrastructure capacity, (2) the right to utilize capacity which is granted, (3) use of the railway infrastructure, (4) train control, (5) use of electrical supply equipment for traction current, (6) all other information required to implement or operate the service for which capacity has been granted. The infrastructure manager takes into account these elements and designs their values and relations by setting up the TAC calculation formula.

As regards the covering of TAC modelling costs, certain guidelines and limitations are provided. Preamble 14 of the Commission Implementing Regulation 909/2015/EU sets forth that "cost modelling requires a higher level of data quality and expertise than methods based on deducting from the full costs certain non-eligible cost categories." Accordingly, the infrastructure manager may calculate the direct costs based on the econometric or engineering modelling or a combination of both approaches considering the modalities for calculation of direct costs.

Aiming to determine the costs to be used in calculation of direct and unit direct costs for the charges, the following approach was set for Montenegro: costs should be determined based on the cost accounting in the Railway Infrastructure of Montenegro, JSC and business records as currently kept. Cost allocation implies the combined econometric and engineering approach.

4.2 TAC modelling settings

The railway network of Montenegro belongs to the category of small networks with a small capacity. Currently, there is no operator competition, one performs only passenger transport and another one only freight transport. Traffic volume shows that passenger traffic is the dominant one. However, if we look at the volume of traffic based on the number of train kilometres, then the differences between the volumes of passenger and freigh traffic are small. The reason for this is dominance of local passenger traffic with shorter distances, whereas the situation in freight traffic is the opposite – dominance of international transports (transit, export and import). All these indicators show that the charge should be primarily based on the costs of using the capacity, i.e. the cost of traffic operation and maintenance of train control equipment (such as signalling, dispatching and communication equipment). This type of costs is best reflected by train kilometres.

At the same time we should bear in mind that the line capacities are poorly utilized. Line utilization ranges from 5% (for the railway line Podgorica – Tuzi) up to 35% (for the railway line Bijelo Polje – Podgorica) [33]. Furthermore, certain line sections have different parameters and performances of the permanent way and substructure. While the railway line Podgorica – Bijelo Polje – Serbian border has the performances of a mountain line with a large number of tunnels and bridges, Podgorica – Tuzi and Podgorica – Bar railway lines have the performances of valley lines, thus resulting in different maintenance costs. In such conditions (poor utilization of line capacities and different maintenance costs for the permanent way and substructure), the charges structure should contain a component reflecting the infrastructure wear and tear costs. Finally, the charges structure should also reflect the market and network size and, accordingly, it should be simple.

Based on the analysis of the results of interviews conducted with the railway market stakeholders and the competent state institutions in Montenegro as well as the above presented general settings, the following basic principles for the new TAC modelling were defined (*Table 2*):

Having thus set the scene by determining the general assumptions and modelling principles, the new TAC structure for Montenegro should be simple, additive and consist of three components. The first component reflects the costs of the capacity use, the second component reflects the infrastructure wear and tear costs and the third one the costs of use and maintenance of electrical supply equipment for traction current.

4.3 TAC modelling

As we explain further in the next paragraph, in order to design a TAC, it is necessary to gather the input data and then transform it into components whose values can be validated.

Table 2 – TAC modeling principle

Area	Modelling principles
Legislation	– to fully comply with all the EU legislation requirements;
Costs (coverage and cost management)	– to be based on the direct costs incurred as a result of operating the train service;
	– to be tailor-made with the implemented degree of cost allocation in the actual bookkeeping of infrastructure manager Railway Infrastructure of Montenegro JSC; – to reflect the degree of network complexity and performances; – to be designed and structured in order to indicate to the infrastructure manager (Railway Infrastructure of Montenegro JSC) the directions and areas for improvement in cost management and rationalization;
Competition	– to enable the infrastructure manager to increase the volume of revenue from charges without jeopardizing the operator competitiveness in the market; – to send clear messages to the operators as to the direction in which they should act in order to reduce their costs related to charges and to be more competitive in the transport market; – to be compatible and in line with utilization of network capacities and network competition.

The inputs to the model can be listed under three headings. The first and second groups of inputs represent the data on traffic performances and network. The third group of inputs will determine the cost elements.

To formalize the TAC model, network is treated as a complex system consisting of four network segments. Modelling of train traffic on the network is based on train traffic volume distribution by network segments measured in train kilometres and gross tonne kilometres. When it comes to the cost modelling, it implies determining the cost that is directly incurred as a result of operating the train service. Calculating direct costs requires familiarity with the relations between the costs of the operation of the train service and the infrastructure performances, rolling stock performances and volume of network operation. In order to determine the relationship between costs and the operation of the train service, many infrastructure managers frequently conduct independent analyses and research in relation to the wear and tear of the substructure, permanent way, catenary, trackside signalling etc.

The proposed methodology for determining direct costs incurred by the operation of train service is based on combining the econometric and the engineering models. Combining these two models was necessary in the case of the infrastructure manager in Montenegro since the econometric modelling of direct costs requires a higher level of data quality for a longer period, which they currently do not have.

For the cost allocation by cost centres, the econometric model, i.e. the bottom-up principle was used and for the cost allocation by network segments (international main type 1 and type 2, international branch and regional) the engineering model was applied. By applying these models, the direct costs of civil engineering, traffic and electrical engineering activities were allocated according to network segments Podgorica – Bijelo Polje, Podgorica – Bar, Podgorica – Nikšić and Podgorica – Tuzi.

The unit access charges per components are defined based on the direct costs incurred as a result of passenger and freight train movements on certain line categories (network segments). Having in mind that the calculation of charges is determined for the planned timetable, the data on the costs and volume of operation is also for the planned year.

A formalization of the above said is a TAC formula such as:

$$C = C_{ca} + C_{wt} + C_{oh} \quad (€) \tag{2}$$

or

$$C = \sum_{i=1}^{2}\sum_{j=1}^{4} K_{oi} \cdot K_{qj} \cdot L_j \cdot c_{caj} + \sum_{i=1}^{2}\sum_{j=1}^{4} L_j \cdot Q_{ij} \cdot c_{wtj} + \sum_{j=1}^{4} L_j \cdot c_{oh} \quad (€) \tag{3}$$

where:

C – charge for the MAP (€),
C_{ca} – charge for using capacities (€),
C_{wt} – wear and tear charge (€),
C_{oh} – charge for using and maintenance of electrical supply equipment for traction current (€),
i – train type (passenger, freight),
j – network segment (international main type 1, international main type 2, international branch, regional),
L_j – route length on the given network segment [km],
K_{oi} – network segment occupancy coefficient in relation to the train type (passenger, freight)
K_{qj} – network segment quality coefficient
Q_{ij} – train weight [t]
c_{caj} – unit charge per network segments for capacity [euro/tkm]
c_{wtj} – unit charge per network segments for wear and tear [euro/gtkm]
c_{oh} – unit charge for using and maintenance of electrical supply equipment for traction current [euro/tkm].

5. RESULTS AND DISCUSSION

The applied approach has resulted in structured costs by formula components (*Equation 2*). Looking at the amount of direct cost accounts recovery by TAC, it is 21% of the total costs of the infrastructure manager in Montenegro. If we go further, the distribution of the direct costs is: traffic operation 32%, signalling maintenance 23%, civil engineering 41% and 4% overhead.

They clearly indicate to the infrastructure manager the priorities in maintenance and investments in order to reduce the TAC and strengthen the operator competitiveness.

The charges structure analysis is based on the values for the planned year, i.e. it includes the values of the coefficients and unit direct costs presented in the below *Table 3*.

The calculated results of the model in relation to the distance and train weight on the main railway line Bijelo Polje – Podgorica – Bar as vari-

Table 3 – Value of elements in TAC formula for planned year

K_{qj} per network segments	Variable	P-BP	P-B	P-N	P-T
	Value	1	0.9	0.8	0.7
c_{caj} per network segments [euro/tkm]	Variable	P-BP	P-B	P-N	P-T
	Value	0.820	0.820	0.451	0.600
c_{wtj} per network segments [euro/gtkm]	Variable	P-BP	P-B	P-N	P-T
	Value	0.001471	0.001457	0.001410	0.001448
K_{oi} per type of train	Variable	Passenger trains	Freight trains		
	Value	1	1.3		
c_{oh} [euro/tkm]	Value	0.0496			

Note: P-BP (Podgorica – Bijelo Polje), P-B (Podgorica – Bar), P-N (Podgorica – Nikšić), P-T (Podgorica – Tuzi)

ables show that the freight train TACs are generally higher by approximately 10% than the passenger train TACs, even for the same distances and train weights. The train speeds permitted by the designed and current condition of the network infrastructure (60–100 km/h) fall within the range of speeds that can be also achieved by freight trains, and they result from the condition of rolling stock and traction power of locomotives that are used on the railway network in Montenegro.

The differences in TACs for passenger and freight trains are best reflected if we are to compare the level of TACs for those types of trains that have a dominant share in traffic. In passenger traffic, the trains in question are EMUs having the weight of 220 t, whereas in freight traffic the trains in question are freight trains having the weight of 1,000 t. For the given main railway line and route, the TACs for the dominant freight train weight is 2.1 times higher than the one for the dominant category of passenger train.

However, if we compare the TACs for passenger trains, then the level of charges is 40% higher for the classical train sets (545 tonnes) than for the EMUs. Therefore, this provides very clear signals to the operators regarding the modernization of the rolling stock and places where the operators should look for profit.

As we pointed out, the focus of this paper is on the ratio of the capacity charge and the wear and tear components in relation to cost management. *Figure 2* reports the ratio between the capacity and the wear and the tear components within the total TAC for up to 2,000 tonne train weight for the main railway line in Montenegro. For the trains of up to 700 tonnes, the capacity components are higher than the wear and tear charges, whereas for the

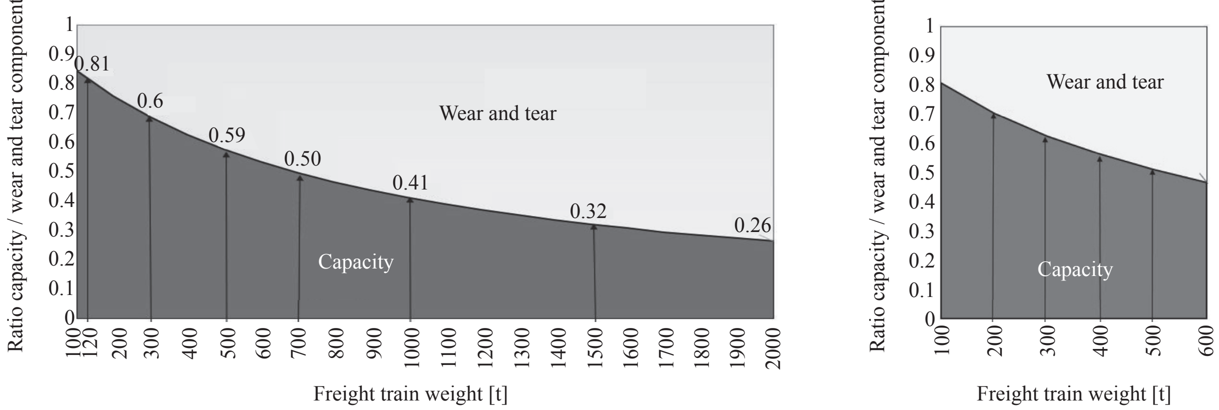

Figure 2 – Ratio of the wear and tear and the capacity components in TAC for main railway line Bijelo Polje – Podgorica – Bar by type of train

trains exceeding 700 tonnes, it is vice versa. In other words, the impact of the wear and tear component is higher with freight trains (trains weighing up to 700 t are always trains with empty wagons). For the most frequent freight train with the weight of 1,000 t, the capacity/wear and tear ratio is 0.41/0.59 percentage. With passenger trains, it is vice versa, i.e. the capacity component is always bigger than the wear and tear component. The capacity charges for the rolling stock and trains that are used on the railway network in Montenegro range from 68% to 50%. For the most frequent passenger train on the network having the weight of 250 tonnes, this ratio is 0.66/0.34 percentage.

The obtained ratios of the capacity and the wear and tear components show that the direct costs are well evaluated by specific cost segments and the network performances and the condition of all infrastructure elements. Passenger operators are very clearly signalled in terms of charge components and elements and their impact on the total access charges by categories of train weights, lines along which they operate and the efficiency of trains on the line in terms of realized journey times.

6. CONCLUSION

In 1991, the European Union initiated the world's biggest and most comprehensive rail reform to date, aiming to set up the SERA and foster its efficiency. Highly complex reforms also required the introduction of TACs for rail infrastructure use. Yet, the reforms were more modelled and oriented towards setting up the SERA, leaving small railways to find their own way around the defined limits of reform systems. However, the TAC modelling is a huge step for small railways both due to the specific properties of small railways and due to the specific requirements and approaches to modelling. This paper sets out to improve methodological approach and structure of TACs for small railways on the Montenegro case study.

Why is the simple additive TAC formula with separate charge components reflecting the direct costs of capacities use, infrastructure wear and tear and maintenance of electrical supply equipment for traction current more advantageous for small railways compared to other TAC models?

Low utilization of network capacities, limiting human, financial and other resources, underdeveloped cost allocation by place of cost origin and by services, insufficient professional and financial resources for research required by weights and coefficients in complex formulas, such as the permanent way and substructure wear and tear coefficient, are some of the potential factors that are requiring simplicity in TAC design and selection of formula elements. Therefore, in the model formulation process, the rule of "count what is countable, measure what is measurable" should be used, instead of imitating other TACs, especially the ones from large railways.

On the other hand, in the conditions where higher independence and liabilities of the infrastructure manager are required in the liberalized railway market, the TAC model should allow the cost management to be improved. Clear and independent structuring of the capacity and the wear and tear components in the TAC model will initiate the processes of better cost allocation and recording, finally resulting in their rationalization.

The business performance, i.e. the cost efficiency of the infrastructure manager and the monitoring method of the IM's accounting data in Montenegro show that small railways firstly have to recognize their costs in order to master them. In the future, along with improvement of the accounting system for data management and analytics in the field of cost allocation and management by services, it will be necessary to gradually modify the values of particular elements in the TAC model structure aiming at increasing its efficiency and fairness. At the same time, by increasing the automation of operation, introducing modern technologies in traffic operation and in other fields, the share of costs for capacities use and the wear and tear costs will have different relative ratios.

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KAKO DEFINISATI NAKNADE ZA MALE ŽELEZNICE – PRIMER CRNE GORE

REZIME

Evropska unija je 1991. godine donela odluku o izgradnji liberalizovanog i jedinstvenog železničkog tržišta. Međutim, u atomiziranom evropskom prostoru, više od polovine železnica se mogu označiti kao male železnice. Regulativa EU upravo zbog velikih razlika nacionalnih železničkih sistema je postavila široke osnove za modeliranje naknada koji je prozveo veliki broj različitih modela. Među brojnim radovima iz ove oblasti veoma je mali broj radova koji razmatra specifičnosti i potrebe malih železnica u modeliranju naknada. Osnovni ciljevi rada su bili: dati odgovore na pitanja kako da se definiše metodološki pristup za kreiranje efikasne strukture naknada kada se radi o malim zemljama i kako da se koncipira struktura naknada u funkciji upravljanja troškovima upravljača infrastrukture. Odgovori na ova pitanja su dati kroz primer železnica Crne Gore – male železnice na Zapadnom Balkanu. Fokus u radu je stavljen na razvoj modela naknada baziranom na efikasnom odnosu dve komponente, naknada za kapacitet i naknade za habanje infrastrukture, što je glavni doprinos ovog rada.

KLJUČNE REČI

naknade za korišćenje železničke infrastrukture; efikasnost; modeliranje; male železnice; studija slučaja; Crna Gora.

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