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A MODEL FOR DEFINING THE MINIMUM STANDARD FOR THE ACCESSIBILITY OF PUBLIC PASSENGER TRANSPORT

Abstract: *The protection of market competition is one of the fundamental concepts of the Community acquis. It is implemented through strict supervision and regulation of subsidized economic activities. The aforementioned acquis must also be accordingly implemented in the field of transport, i.e. the field of providing transport services. The provision of public passenger transport services is characterized as an activity of general economic interest, for which public service contracts must be concluded. With that in mind, the paper presents one of the possible models for defining the minimum standard for the accessibility of public passenger transport. The model is based on the available statistical data and it can be used in the preparation and implementation of tenders for the conclusion of public service contracts to which all interested carriers can apply under the same conditions. The proposed methodology is simple to apply and it is based on generating the needs for movement depending on the structure and complexity of life functions correlated with the size of the settlement. Research results confirm the possibility of applying the mentioned method as referential in defining the minimum scope of the public passenger transport service at all levels.*

Keywords: *Public Transport; Quality of Life; Minimum Accessibility Standards; Mobility.*

1. Introduction

The protection of market competition is one of the fundamental concepts of the Community acquis. The aid system is specifically and very elaborately worked out through the European directives. It appropriately applies through all industries, including transport. In order for the aid to be properly implemented, the European Union pays special attention to "hidden" aid for carrying out economic activities. "Approved aid" and "unapproved aid" are analyzed separately. Activities which have wider socio-economic significance are recognized as activities, i.e. "services of general economic interest."

It has been defined that the "public passenger transport" be treated as a transport service of general economic interest available to all in a non-discriminatory manner and on a permanent basis, and that the "public service operator" be treated as a public/private carrier (or group of carriers) who provide public passenger transport services (Ceder, 2007). The definition covers the local, regional and national public passenger transport service. It has been stipulated that if the competent authority decides to grant an exclusive right and/or compensation of any nature to the operator of its choice (in exchange for fulfilling the obligations of public service performance), it does so under the public service contract.

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Taking into account the aforementioned, the paper analyzes the conditions under which the competent authorities grant public service operators of public rail and road passenger transport with exclusive rights in exchange for fulfilling the obligations of public service performance. A model for defining the minimum standards for public passenger transport services has been developed and proposed, and it can be used as a basis for conducting public tenders and concluding contracts on the provision of public road passenger transport services.

2. Review of binding legal acts of the European Union in the field of public passenger transport

The European Union strictly controls and protects market competition at all levels. Although member states have the possibility to adopt their own legal acts, the application of basic European directives is mandatory. In the field of public passenger transport, the mandatory EU regulations that apply are the following:

- Regulation (EC) No 1370/2007 of the European Parliament and of the Council on public passenger transport services by rail and by road
- Regulation (EU) 2016/2338 of the European Parliament and of the Council amending Regulation (EC) No 1370/2007 concerning the opening of the market for domestic passenger transport services by rail.

The basic provisions of these regulations are elaborated below.

2.1. Regulation (EC) No 1370/2007 on public passenger transport services by rail and by road

Within the framework of the Regulation (EC) No 1370/2007, the following is pointed out: The main objectives of the Commission's White Paper of 12 September 2001 "European transport policy for 2010: time to decide" are to guarantee safe, efficient and high-quality passenger transport services through regulated market competition, while also ensuring transparency and the provision of public passenger transport services. Furthermore, what also has to be taken into account are the factors of social, environmental and regional development, i.e. special tariff conditions must be offered to certain groups of passengers such as pensioners, and inequalities between carriers from different member states that may lead to significant distortions of market competition must be eliminated.

At present, at the EU level, many land passenger transport services, necessary in terms of the general economic interest, cannot be provided on a commercial basis. Competent authorities of member states must be able to act to ensure the provision of such services. Mechanisms that can be used to ensure the provision of public passenger transport services include the following:

- granting exclusive rights to public service operators
- granting financial fees to public service operators and
- establishing general rules for the operation of public transport that are applicable to all operators.

If member states decide, in accordance with this Regulation, to exclude certain general rules from their scope, the general State aid regime should apply.

Many member states have enacted legislation providing for the award of exclusive rights and public service contracts at least in part of their public transport market, based on transparent and fair competitive contracting procedures. As a result, trade between member states has significantly developed and several public service operators now provide public passenger transport services in more than one member state. However, changes in national legislation have led to differences in the procedures applied and they have created legal uncertainty about the rights

of public service operators and the obligations of competent authorities.

In order to be able to organize their public passenger transport services in a way that best suits the needs of the public, all competent authorities must be free to choose their public service operators, taking into account the interests of small and medium-sized enterprises, under the conditions laid down in this Regulation. Furthermore, in order to guarantee the application of the principles of transparency, equal treatment of competing operators and proportionality when awarding fees or exclusive rights, it is necessary that the public service contract between the competent authority and the selected public service operator specify the nature of the public service obligation and the agreed fee. The form or title of the contract may differ according to the legal systems of member states.

Following the principle of subsidiarity, competent authorities may establish social and qualitative criteria to maintain and improve quality standards for public service obligations; for example, in relation to minimum working conditions, passenger rights, the needs of persons with reduced mobility, environmental protection, safety of passengers and employees, and also the obligations under collective agreements and other rights and agreements relating to the workplace and social protection at the place of service. In order to ensure transparency and comparable conditions of market competition between operators, and to eliminate the risk of social dumping, competent authorities should be able to introduce certain social and service quality standards.

The fee awarded by competent authorities to cover the costs incurred in fulfilling the public service obligation must be calculated in a way that prevents overcompensation. If the competent authority plans to conclude a public service contract without subjecting it to a competitive tendering procedure, it must also comply with detailed rules that ensure that the amount of the fee is appropriate and that it reflects the efforts aimed at the efficiency and quality of service.

"Public service obligation" refers to a requirement specified by the competent authority to provide public passenger transport services of general interest which the operators, if only their commercial interests were taken into account, would not undertake at all or would not undertake them to the same extent or under the same conditions without charge.

2.2. Regulation (EU) 2016/2338 amending Regulation (EC) No 1370/2007 concerning the opening of the market for domestic passenger transport services by rail

Within the framework of the Regulation (EU) 2016/2338, additional emphasis is placed on the following: Competent authorities should determine the specifications of public service obligations in public passenger transport. Such specifications should be in line with policy objectives, as set out in the member states' public transport policy documents.

The specifications of public service obligations in public passenger transport should, where possible, create positive network effects, inter alia in terms of improved service quality, social and territorial cohesion or the overall efficiency of the public transport system.

Public service obligations should be in line with the public transport policy. However, this does not entitle the competent authorities to receive a certain amount of funding.

When preparing public transport policy documents, relevant stakeholders should be consulted in accordance with the national law. The stakeholders could be carriers, infrastructure managers, employee organizations and representatives of public transport service users. For the fulfillment of public service obligations by public service operators, fees should be paid appropriately in the case of public service contracts that were not awarded on the basis of a competitive tendering procedure, all in order to ensure the long-term financial sustainability of public

passenger transport services in accordance with the public transport policy requirements. In particular, such fees should promote the maintenance or development of efficient management by public service operators and the provision of passenger services of a satisfactorily high standard.

3. Methodology for setting the minimum standards for the accessibility of public passenger transport

The term "mobility" can be understood differently. In general, it represents a timed movement between the origin and destination of travel by using different transport branches (modes of transport) (Gillis, Semanjski, & Lauwers, 2016; Marsanic & Krpan, 2015; Pupovac, Maršanić, & Krpan, 2015). Total mobility represents the total number of travel within the observed area, regardless of the mode and purpose of travel (Gillis, Semanjski, & Lauwers, 2016; Marsanic & Krpan, 2015; Pupovac, Maršanić, & Krpan, 2015; Amaral, 2018). Moreover, mobility can be defined as a measure of the efficiency of the transport system in terms of connecting spatially separated locations, where mobility is used as a key indicator of the efficacy of the functionality of the transport system (Rashidy, Ahmed, Muller, & EL Rashidy, 2014). Finally, for the research presented in this paper, the treatment of the notion of urban mobility as an opportunity for organized and meaningful movement of individuals in an urban space is the appropriate choice (Vidović, Šoštarić, & Budimir, 2019).

One of the fundamental factors for ensuring the adequate mobility of population is precisely a well-organized public passenger transport system. Minimum accessibility standards represent the basic offer of public transport when defining the network of public road passenger transport lines and their intervals (dynamics) of departures, taking into account the minimum needs of residents for daily migrations.

The network of public transport lines is planned in such a way that it, as far as possible, meets the total transport need. Numerous global and European research, based on the data on the travel habits of the population, confirm that in public passenger transport, it is primarily necessary to provide public passenger transport for the needs of work and education, as well as for the needs of ensuring access to medical services and the services provided by the local, regional and state authorities (basic social services). It is confirmed that the public transport of passengers is used to a much lesser extent to meet the recreational, tourist and other needs of the population (Gabrovec, 2006).

Furthermore, most daily migrations and the work of public institutions take place on working days from Monday to Friday, which is also the minimum time frame for providing the aforementioned service (Haussner, 2001).

Taking those assumptions into account, a model for dimensioning the minimum number and interval of public passenger transport lines at all levels has been adequately structured.

After the analysis of scientific and professional documentation and available reliable statistical indicators, the criteria for defining the minimum standard for the accessibility of public road passenger transport were structured. The standards propose a minimum number of lines for the cases such as:

- From remote construction areas of the settlement to the center of the settlement and back (intercity transport within one local self-government unit).
- From the center of the settlement to the centers of local self-government units (intercity transport within one local self-government unit).
- From the center of local self-government units to the centers of counties/urban agglomerations and areas (intercity transport between two and/or more local self-government units).

- From the center of regions to the centers of other (neighboring) regions (performed as regional transport)

The methodology for defining the minimum standards for the accessibility of public road passenger transport will be presented below. The methodology has been tested in practice and it will be applied on the territory of the Republic of Croatia. It is structured in two basic parts. The first part includes an analysis of published, reliable and available data sets, while the second part elaborates the methodology for defining the minimum standards based on the chosen publicly available data.

3.1. Analysis and assessment of the reliability of publicly available data on transport needs and demand

Since decision-making in transport engineering is based on quality economic and demographic data and mobility data, sets of publicly available and reliable data had been analyzed before the research was conducted. In this way, the possibility of using data based on individual transport research was avoided, since that data are often – due to implementation errors or different interpretations – not unambiguous and comparable in the entire field of research.

The analysis of scientific and professional literature and available strategic documentation from the transport sector confirmed that the majority of public passenger transport users on local and regional lines are pupils and students and the employed population. Therefore, it has been accepted that the constantly recurring travel, travel on the home-work and house-school/university relations are the basic travels that the population makes. Additionally, in the areas where pensioners have a free ticket to use public transport modes, the share of their travel is also significant.

For quality articulation of these travels, it is necessary to have data on the spatial distribution of the residence of employed persons and pupils/students, as well as the data on the workplaces, i.e. the data on the number of pupils and students and the spatial distribution of schools/universities and workplaces in the analyzed transport zones. It is crucial for transport modeling to be able to connect the data on the aforementioned movement (origin and destination). In other words, the data on the place of residence and the data on workplaces/number of pupils/students must be comparable (Gabrovec, 2006; Krpan, Milković, & Hess, 2014).

For this reason, publicly available data sets were analyzed, of which the most important for defining the minimum standards are the data on (Kos, Brlek, & Franolić, 2012):

- workplaces per a particular area,
- number of residents per a particular settlement
- number of pupils in schools, i.e. number of students at higher education institutions.

The conducted analysis shows that, although the majority of the data exists and is publicly available, there is no possibility of their automatic pairing and thus no possibility of their direct use in conducting such traffic research (there is no possibility of creating origin-destination travel matrices).

Taking into account the previous research on the levels of generating travel needs, the availability of published statistical data related to the number of residents, i.e. the size of particular settlements was analyzed. At the same time, the paradigm that settlements with a larger number of residents, as a rule, have more content that generates movement, and thus represent a greater attractor of transport demand was accepted.

The system of spatial planning was afterwards analyzed; and with it, through the analysis of the existing situation, the division of space according to administrative centers and the foci of development based on the existing contents in space (economic, administrative, social…) was further

elaborated. At the same time, the paradigm that a settlement of a higher hierarchy has more content that influences the generation of travel, thus making the settlement a more significant attractor of transport demand, was accepted.

Through this analysis, it was determined that all European countries have a reliable database of the number of residents at the level of individual settlements and of the estimates of the number of residents for each year between two censuses (which are usually conducted in ten-year shifts). At the same time, the data on the number of residents in a settlement is one of the basic indicators of the total volume of movement needs. Accepting this fact, the methodology of this research lies in the analysis of movement needs based on the functional structuring of settlements and on defining the system of connections between settlements.

3.2. Methodology for defining the minimum standards for the provision of public passenger transport services

After available and reliable mobility indicators were identified, the development of a methodology for defining the minimum standards for the provision of public passenger transport services began. The developed methodology consists of three interrelated steps:

- First step: Analysis and structuring of settlements in the area of performance
- Second step: Defining the optimal network of public passenger transport lines and
- Third step: Determining the minimum number and intervals of the departures of public transport means on each line

The steps are described below.

Analysis and structuring of settlements in the area of performance

Given the analyzed available and reliable data sets, the structuring of public passenger transport lines depending on the size and functional characteristics of a settlement (as origin/destination points) was accepted as fundamental for defining the minimum standards for public passenger transport accessibility (Krpan, Milković, & Štimac, 2014).

It was suggested that the structure of the settlement size viewed through the number of residents in the settlement should be treated according to the structuring of settlements when defining the importance of individual roads. In other words, settlements can be structured in ways that recognize their fundamental role with regard to the contents important for the life of residents in five levels (Marinović-Uzelac, 2001; Štimac, 2010; Vresk, 2002):

A. Center of the region
B. Center of the local self-government unit in which there are facilities such as:
   - high school and/or higher education institution or
   - court or
   - regional administration offices or
   - other institutions at the regional and/or national level providing services of public interest
C. Centers of local self-government units (regardless of the number of residents)
D. Other settlements larger than 300/500 residents
E. Other settlements smaller than 300/500 residents

In the structuring of defining the system of transport connections between the recognized levels of settlements, we started from the assumptions that in consideration, all settlements are structured according to the stated criteria.

The lowest level of settlements for which minimum accessibility standards are defined are settlements with 300 (500) and more residents (level D settlements).

An additional criterion for the inclusion of level D settlements (the lowest level of settlements included in defining the minimum

accessibility standards), regardless of the number of residents, would be the distance from the nearest level C settlement. It is proposed that level D settlements be included in the minimum standard only if their distance from the nearest public transport stop/station of level C settlements is greater than two (2) km.

Therefore, the first step in defining the minimum standards for the provision of public services in road passenger transport is:

- Analysis of the structure of the settlement with regard to the number of residents, administrative role (center of the region or local self-government unit) and contents in the settlement.
- Structuring settlements on five levels (A, B, C, D, E) with regard to their administrative-functional role.
- Structuring of level D settlements onto settlements that are more than 2 km away from higher level settlements (and that are included in the system of defining the minimum standards, i.e. that are included in the network of public passenger transport lines in road transport).

Defining the optimal network of public passenger transport

The second step in defining the minimum standards for public services in road passenger transport is to define the optimal lines, i.e. connections between settlements, which will ensure quality transport accessibility. Designing public passenger transport lines is a very complex task. First of all, it is necessary to satisfy different interests. For example, the traveler will want a direct connection between all settlements, while the investor will seek a centralized system with one connection from a higher level origin to each of the lower level settlements within the same functional unit in order to reduce costs (Figure 1) (Kutz, 2004). Therefore, the primary task when defining the network of public transport lines is to determine the optimal variant of a possible transport connection which will increase accessibility and reduce network costs. When making decisions about the structure of the entire network, it is important to accept the requirements of end users and to define a quality transport structure through open discussions. Nevertheless, at the theoretical level, it is necessary to set certain assumptions from which later corrections will derive qualitative conclusions. If we accept the fact that the hierarchy of the network of lines is determined by transport supply and demand, and if we take into consideration that it perceives the gravity model as the starting point for establishing a system of connections, it is proposed that the hierarchy of the network of lines be directly related to the hierarchy of settlements.

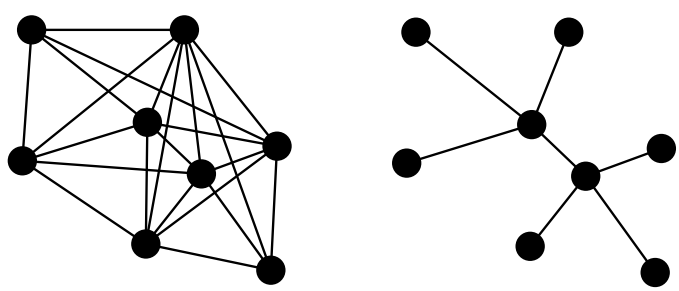

Figure 1. The difference in comprehending the optimal network structure from the user's and investor's perspective (Kutz, 2004) (p.2.12)

Based on the aforementioned, to define the minimum standards for the accessibility of public road passenger transport, it is proposed that the lower settlement level always be connected with the higher settlement level within its own local or regional self-government unit (for the centers of regions).

Exceptionally, settlements may be connected with the first higher settlement level outside their own local self-government unit in cases when this distance does not exceed:

- 10 km to connect level D settlements with level C settlements
- 30 km to connect level C settlements with level B settlements
- 50 km to connect two neighboring level B settlements outside the same local or regional self-government unit
- 50 km to connect level B settlements with level A settlements outside their own region.

Only in exceptional cases and with special justification, greater distances may be allowed. For example, permission will be granted in the cases of settlements where there are significant geographical barriers such as mountains, lakes, rivers, seas, etc. on the way to higher-level destinations within their own administrative boundaries (local and regional self-government units), and there is no transport infrastructure through which the centers could be connected.

The assumption that a higher level settlement has all the functions of a lower level settlement and a number of additional functions is the basis for the paradigm of a possible direct connection of a lower level settlement with a settlement that is functionally higher by two levels (e.g. level D settlements with level B settlements or level C settlements with level A settlements). That may happen in cases when the settlements that are higher by two levels are closer to each other in relation to the settlements whose levels directly follow one another (either in departure or arrival), as shown in Figure 2. Calibrating each model is possible in special cases when the settlements of the centers of regions have no dominant functional role in relation to some of the level B settlements.

Additionally, if one of the settlements of the same or lower level is located on the route which connects settlements of the same or higher level, it is considered that the minimum service has been satisfied and no additional minimum departures (standards) of public passenger transport lines are laid down for that settlement. As a mandatory condition when defining public transport lines, it is necessary to point out that for minimum accessibility standards, it is compulsory to follow the rule that all settlements covered by the minimum standards found on a route of the state, regional or local road must be covered by one line with the appropriate number of stops (which annuls the condition of the minimum number of departures for all settlements along the route, considering the fact that for the settlements of the same level, it will be covered by the line conditioned for the first settlement on the line).

Moreover, it is necessary to ensure that when defining public passenger transport lines, separate construction areas of business and/or production purposes (work and free zones) with a built area of more than 3 ha and with more than 100 employees in the zone be included.

When calculating the minimum standard for the settlements (regardless of the level) through which interregional public transport lines pass and have a stop, it has to be reduced by the number of interregional lines that meet the needs of the local population for transport.

If there is a railway connection between the settlements and there is sufficient capacity, it is necessary to avoid parallel rides in relation to the train and bus running at the same time on the same route.

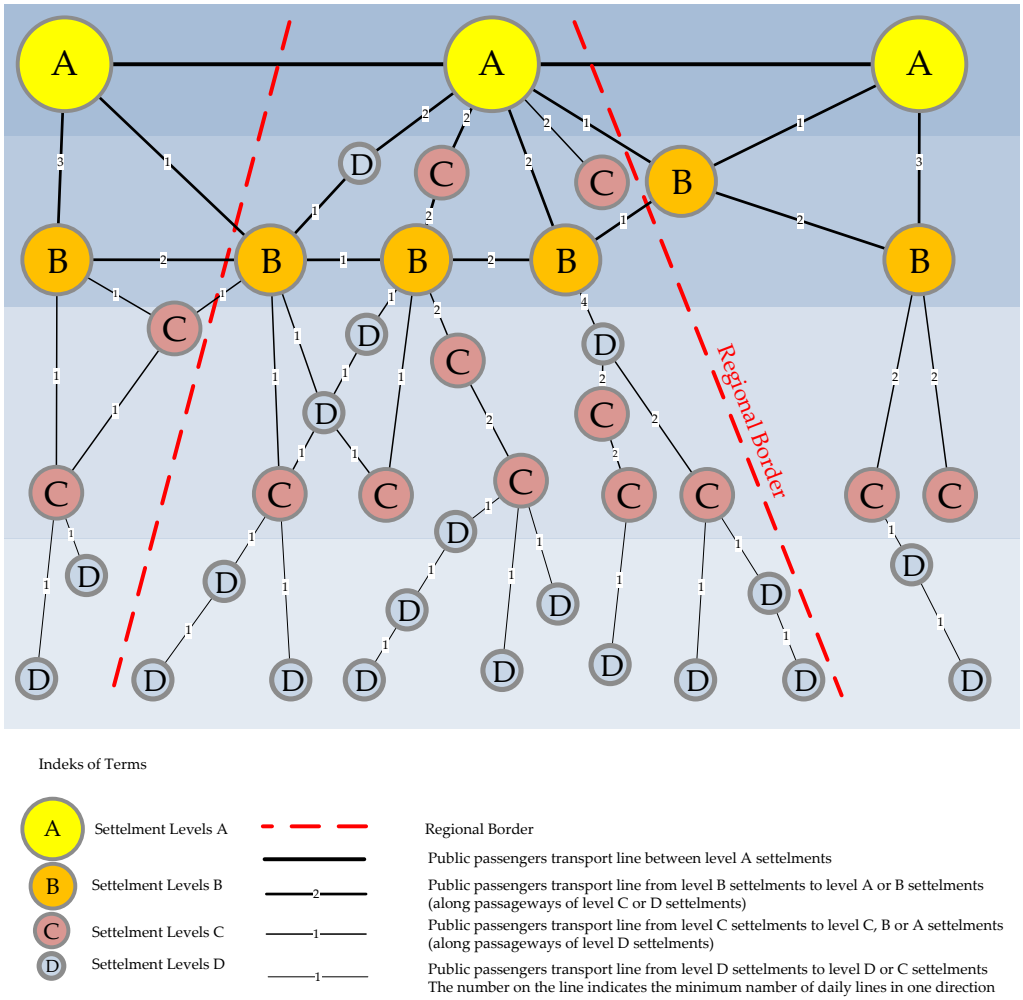

Figure 2. Minimum standards for the accessibility of connecting settlements according to functions (Krpan, Milković, & Hess, 2014)

It can be said that the second step in defining the minimum standards for public services in road passenger transport includes defining the optimal lines, i.e. connections between settlements, which will ensure quality accessibility while respecting the following conditions:

- a lower settlement level must always be connected to a higher settlement level within its own local or regional self-government unit (for county centers),
- only in exceptional cases can settlements be connected with the first higher settlement level outside their own local self-government unit (according to the given criteria),
- if one of the settlements of the same or lower level is located on the route which connects settlements of the same or higher level, it is considered that the minimum service has been satisfied and no additional minimum departures (standards) of public passenger transport lines are laid down for that settlement,
- it is compulsory to follow the rule that all settlements covered by the minimum

standards found on the route of the state, regional or local road must be covered by one line with the appropriate number of stops (which annuls the condition of the minimum number of departures for all settlements along the route, considering the fact that for the settlements of the same level, it will be covered by the line conditioned for the first settlement on the line).

- it is necessary to ensure that when defining public passenger transport lines, remote construction areas of business and/or production purposes (work and free zones) be included, since they generate a large number of home-work trips,
- when calculating the minimum standard for the settlements (regardless of the level) through which interregional public transport lines pass and have a stop, it has to be reduced by the number of interregional lines that meet the needs of the local population for transport.

Defining the optimal network of public passenger transport lines

Moreover, it is necessary to ensure that when defining public transport lines, separate construction areas of business and/or production purposes (work and free zones) with a built area of more than 3 ha and with more than 100 employees in the zone be included.

The third and at the same time the last step in defining the minimum standards for the accessibility of public passenger transport refers to determining the minimum number and the interval of the departures of public passenger transport means on each line. It is mandatory to provide a return journey for each of the departures on the line.

When defining the interval of lines, i.e. when defining the lines of public road transport of passengers, it is necessary to pay special attention to the regular needs of the population. Hence, line intervals need to be adjusted in terms of when the population leaves for work or school/university, both for the first (morning) and second (afternoon) shift. In the case of origins that have a minimum of one set line, it is necessary for it to meet the needs of workers/pupils/students who work/attend classes in the first (morning) shift.

It is assumed that special emphasis is given to connecting the settlements with the centers of local self-government units, i.e. to connecting the seats of local self-government units with each other and with the seat of the region, respecting the travel from home to and from work/school/university in the morning and afternoon shifts.

As it has already been mentioned, the data needed to plan public transport lines, especially the data on transport demand and supply, are difficult to acquire or are completely unavailable. Due to this, the proposals for minimum standards are given on the basis of:

- available scientific and professional literature,
- examples of good practice in Europe and the United States,
- supply standards defined in the analyzed strategic transport documents,
- facts about the dependence of minimum standards on the economic and political factors, i.e. on the possibilities and readiness to provide the coverage of costs.

Optimal standards are based on the assumption of the organization of the public transport of passengers by applying the clock-face timetable, i.e. the departure of buses on one line at equal intervals. The clock-face timetable is used in almost all countries with the most developed public transport (Switzerland, Germany, Austria, etc.). In professional literature, the following departure intervals are seen as optimal:

- 20-60 minutes depending on the service type and period (Ceder, 2007)
- 30-60 minutes depending on the service period (City Of Waukesha, 2011)
- Examples of good practice: 30-120 minutes, (usually 30 minutes in peak

period, usually 60 minutes in off-peak period for regional transport)
- 15-120 minutes (various strategic documents)

As an expression of political will and economic readiness, the example of Switzerland is cited, which defines the minimum standard as follows: "regional public transport of passengers between settlements larger than 100 residents must be provided at least four times a day, with at least 32 passengers a day travelling".

Starting from the accessibility standards optimally structured in the aforementioned manner, minimum accessibility standards that should meet the basic transport needs of the population are proposed:

- For level D settlements, a minimum of one daily return journey
  - It is assumed that the lowest level of the public transport service is the provision of transport for the departure to work/school/university in the morning hours and return in the afternoon hours.
- For level C settlements, a minimum of two daily return journeys
  - This level of settlement should optimally, in the clock-face timetable, have an average of a 60 minutes interval (which can be thickened at the peak period or thinned out at the off-peak period) in the period from 5:00 am to 11:00 pm, which makes a total of 19 departures. It is considered that 10% of departures in relation to the optimal number may represent an appropriate minimum standard. Hence, it is possible to introduce either two departures to different destinations in the morning or one departure in the morning and one in the afternoon (1st and 2nd shift) to one destination.
- For level B settlements, a minimum of five daily return journeys
  - This level of settlement should optimally, in the clock-face schedule, have an average departure frequency of 45 minutes in equal intervals (which can be thickened at the peak period or thinned out at the off-peak period) in the period from 5:00 am to 11:00 pm, which makes a total of 25 departures. It is considered that 20% of departures in relation to the optimal number for this settlement level may represent an appropriate minimum standard. Therefore, it is possible to introduce a minimum of five departures with return journeys to the neighboring level B settlements or level A settlements. It is recommended to take into account the need to go to work/school/university in the first and second shift.
- For level A settlements, what needs to be considered in terms of individual cases is the need to connect with level B settlements regardless of the return journeys to lower level settlements, the need to connect with settlements of the same level or of the same level in the neighboring county, i.e. the settlements of the same or lower level should be connected at least at the level of return journeys according to the standards laid out for level B settlements.

At the same time, bus lines should be coordinated with each other in such a way that it is possible to change from one line to another in the shortest possible time. The transfer time when an aligned clock-face timetable is applied is usually 5 minutes if it is a transfer from, for example, a bus to another bus or a train to another train, and 15 minutes if it is a transfer from a bus to a train or vice versa. Other studied standards for transfers on bus lines range between 3-8 minutes. An overview of the proposed minimum standards, possible connections and maximum distances is given in Table 1.
Exceptions to the structuring of settlements may be specially organized lines of public passenger transport to remote construction areas outside the settlement of business or

production purposes (work zones) to which a large number of workers gravitate.
Since they are not directly related to the minimum living needs of the population, other remote construction areas intended for sports, recreation, tourism and other purposes were not considered when determining the minimum standards. The challenge in defining accessibility standards can lie in the unrealistic structuring of large cities, which are often recognized as a single settlement. In these cases, all the criteria implemented at the level of other settlements should be applied to town districts or local councils, taking into account the gravitational area of individual bus lines.
Ultimately, defining the capacity of transport means will depend on the calculations of specific transport needs.
The third and final step in defining the minimum standards for public services in road passenger transport is:

- Determining the minimum number of the departures of public transport means depending on the category of the settlement (but they do not necessarily have to be on the same lines)
  - Level A settlements according to the needs
  - Level B settlements – minimum 5 return lines
  - Level C settlements – minimum 2 return lines
  - Level D settlements – minimum 1 return line
- Defining public passenger transport lines in accordance with the established minimum number of departures and the needs of the population (according to the same or different destinations in the morning or in the morning and afternoon)
- Defining line intervals
  - for each of the departures on a particular line, it is necessary to provide a return journey on the same line,
  - it is necessary to take special care of the regular needs of the population (line intervals should be adjusted in terms of when the population leaves for work or school/university, both for the first (morning) and for the second (afternoon) shift),
  - in the case of origins that have a minimum of one set line, it is necessary for it to meet the needs of workers/pupils/students who work/attend classes in the first (morning) shift,
  - if there is a railway connection between the settlements and there is sufficient capacity, it is necessary to avoid parallel rides in relation to the train and bus running at the same time on the same route.
- Defining the required capacities of transport means depending on the calculations of specific transport needs.
- Harmonizing proposals for the minimum standards developed by local and regional self-government units with the relevant ministry in charge of transport.
- Adoption of minimum standards by national governments.

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- Defining public passenger transport lines in accordance with the established minimum number of departures and the needs of the population (according to the same or different destinations in the morning or in the morning and afternoon)
    - Defining line intervals
        - for each of the departures on a particular line, it is necessary to provide a return journey on the same line,
        - it is necessary to take special care of the regular needs of the population (line intervals should be adjusted in terms of when the population leaves for work or school/university, both for the first (morning) and for the second (afternoon) shift),
        - in the case of origins that have a minimum of one set line, it is necessary for it to meet the needs of workers/pupils/students who work/attend classes in the first (morning) shift,
        - if there is a railway connection between the settlements and there is sufficient capacity, it is necessary to avoid parallel rides in relation to the train and bus running at the same time on the same route.
- Defining the required capacities of transport means depending on the calculations of specific transport needs.
- Harmonizing proposals for the minimum standards developed by local and regional self-government units with the relevant ministry in charge of transport.
- Adoption of minimum standards by national governments

Table 1. An overview of the minimum standards, possible connections and maximum distances

Settlement type	Average departure frequency	Maximum departure number	Minimum standard	Possible connection	Maximum distance	Remarks
D		1	1	from D to C	not less than 2/3 km	
C	60'	19	2	from C to B and/or A	30 km	if A is closer than B
B	45'	25	5	from B to B and/or A	50 km	
A			5	from A to B	50 km	Exceptionally if there are attractors in B for the residents from A

Meanings of terms in the table
departure: one bus departure from a settlement on one line in one direction
maximum departure number: the number of departures in the time interval between 5 am and 11 pm on weekdays based on the clock-face timetable
average departure frequency: average interval of bus departures between two settlement types (e.g. from level C settlement to level B settlement),
minimum standard: the number of bus departures in one direction in the interval between 5 am and 11 pm.

Defining the optimal network of public passenger transport lines

When defining the minimum standards for public services, it is important to consider and comprehensively take into account all factors that may affect the generation of the needs for movement and then the factors that affect the fulfillment of these movements.

As the number of residents in a settlement is one of the basic indicators of the total volume of mobility needs, it is expedient to consider sustainable models of public transport services of passengers that are applicable in areas with lower transport demand such as micro-transport or on-call transport. This can be applied for the purpose of connecting settlements recognized through the category E, i.e. settlements with less than 300 (500) residents.

Micro-transport is recognized as a form of public transport of passengers by a car of category M1 or a bus of category M2, and it is performed in areas where there is no organized public transport of passengers, i.e. in areas characterized by low levels of transport demand. Based on the examples of good practice in EU countries, micro-transport could be organized as transport on demand and as taxi transport on demand.

The public transport of passengers on call has a variable route and timetable. It is a public passenger transport subsystem that is conceptually located between a passenger car and a standard public passenger transport bus subsystem, which provides system users with the most flexible service in terms of vehicle routes, service times, vehicle selection, carrier selection, tariffs and usage. The flexibility of each of the service elements varies, from a transport service with fully defined (fixed) elements to a fully flexible service where the elements are determined at a time close to the service.

Public on-call (on-request) transport in the context of this document may include the transport of passengers (by M1 vehicle or M2 category vehicles):

- from a public passenger transport station/stop to another public passenger transport station/stop, including specially marked micro-transport stops, or
- transport from “house doors” to a predetermined station/stop and vice versa.

In previous examples, the boarding and disembarking of passengers is done only with and in the place specified in the written, electronic or telephone order, as opposed to regular transport, which serves all timetable-defined stops.

The method of organizing transport can be different and it can take place according to a predefined timetable (where, unlike line transport, possible departures are defined) or without a predefined timetable, connected/coordinated with regular transport or completely independent of regular transport.

As it has already been mentioned, micro-transport could be organized as taxi transport on request. In this case, taxi transport on call means that the transport of passengers by taxi from the public transport station/stop to the home address or a specially marked place of stopping the taxi on call is specified in the order and vice versa at a predefined tariff for micro-transport.

On-call taxi transport is often organized as an addition to the tourist and especially catering offer, where guests of catering facilities are transported by taxi during the weekend and when there is no offer of regular public transport. In that case, the taxi tariffs are the same as the ones in public transport.

4. Research results

Verification of the theoretical results of the research was conducted on the regions within the Republic of Croatia as the basis for testing the set theoretical assumptions:

- structuring settlements by type,
- testing the distances between settlements,

- identifying the possibilities of connection in terms of minimum standards.

Characteristic regions on which the testing was conducted were selected based on the following criteria:

- population density,
- number of cities,
- number of municipalities.

Each criterion was scored separately in order to highlight the region that in the sum of all three criteria achieves the most points, the least points, and which region is closest to the average (Table 2).

Table 2. Overview of scoring the regions according to the selected criteria

	Highest values				**Lowest values**				**Average values**			
Region	resident/ km^2	number of cities	number of municipalities	total number of points	resident/ m^2	number of cities	number of municipalities	total number of points	resident/ m^2	number of cities	number of municipalities	total number of points
Zagreb	6	6	4	16				0		6	7	13
Krapina-Zagorje	7	5	4	16				0		8	7	15
Sisak-Moslavina		4		4	6		7	13		9	3	12
Karlovac		3		3	8	6	5	19		8	7	15
Varaždin	8	4	3	15			3	3		9	9	18
Koprivnica-Križevci			3	3	1	8	3	12	7	6	9	22
Bjelovar-Bilogora		3		3	3	6	4	13	3	8	8	19
Primorje-Gorski Kotar	4	8	3	15			3	3	5	4		9
Lika-Senj				0	9	7	8	24		7	1	8
Virovitica-Podravina				0	5	8	7	20		6	3	9
Požega-Slavonia		3		3	4	6	9	19	1	8		9
Brod-Posavina	3		5	8	2	9		11	6	5	6	17
Zadar		4	6	10				0	4	9	4	17
Osijek-Baranja	1	5	8	14				0	9	8		17
Šibenik-Knin				0	7	6	6	19		8	5	13
Vukovar-Srijem		3	5	8		6		6	9	8	6	23
Split-Dalmatia	5	9	9	23				0				0
Istria	2	7	7	16				0	8	5	2	15
Dubrovnik-Neretva		3		3		6	5	11	9	8	7	24
Međimurje	9		3	12		8	3	11		6	9	15

One of the analyzed regions was the Vukovar-Srijem County which, according to the 2011 Census, has 179 521 residents.

The first step in testing the methodology was to analyze the number of local self-government units within the region. It was determined that the region has 5 cities (Vukovar, Ilok, Vinkovci, Županja and Otok) and 26 municipalities, and that the local self-government units are divided into 84

settlements. Finally, the number of residents was determined for each settlement.

Additionally, it was necessary to check which social/administrative/economic functions important for generating travel belong to particular seats of local self-government units, which resulted in the division of settlement levels, in accordance with the proposed methodology, into the following:

A Center of the region – Vukovar

B. Center of the local self-government unit in which there are facilities such as:
   - high school and/or higher education institution – Vukovar, Vinkovci, Županja, Ilok
   - court - Vukovar
   - branches of state administration offices or county offices – Vukovar, Vinkovci
   - hospitals – Vukovar, Vinkovci

C. Centers of local self-government units - town (Otok), municipality (Andrijaševci, Babina Greda, Bogdanovci, Borovo, Bošnjaci, Cerna, Drenovci, Gradište, Gunja, Ivankovo, Jarmina, Lovas, Markušica, Negoslavci, Nijemci, Nuštar, Privlaka, Stari Jankovci, Stari Mikanovci, Štitar, Tompojevci, Tordinci, Tovarnik, Trpinja, Vođinci, Vrbanja)

D. Other settlements with over 300/500 residents – 41 settlements with over 300 residents, of which there are 28 settlements with more than 500 residents

After defining each level of a settlement, the next step was to test the proposed model, i.e. to determine the actual transport distance between A and B levels with settlements of the same and first neighboring levels (Table 3).

After mutual distances were defined and the spatial characteristics of the region and particular local self-government units were analyzed, the lines for public road passenger transport were proposed in accordance with the proposed methodology, and they are presented below in the form of tables and graphs.

This was followed by a graphical structuring of the network of lines, which is presented below (Figure 3).

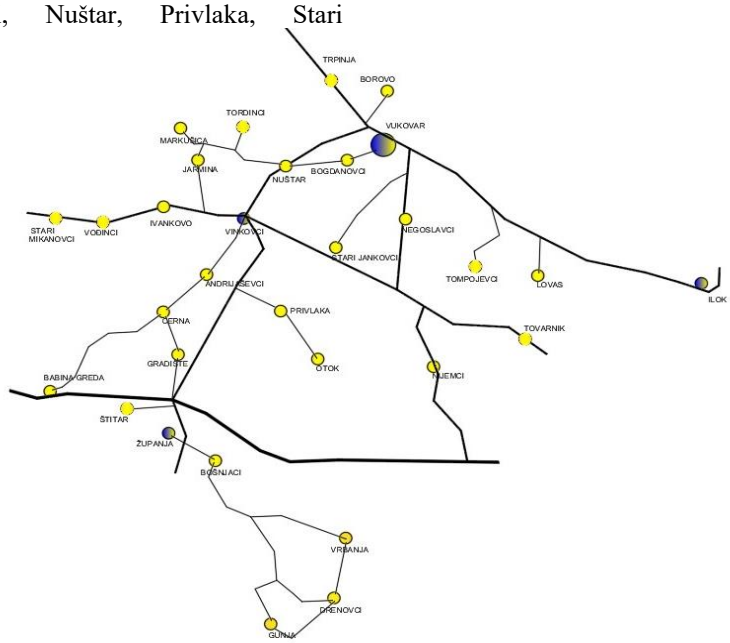

Figure 3. Overview of settlements in the Vukovar-Srijem County to the level C

Table 3. List of possible lines in the Vukovar-Srijem County

Possible lines to the level B settlement - Ilok
D Ilok (Bapska, Šarengrad)
Possible lines to the level B settlement - Županja
C Gunja; C Drenovci + D Drenovci (Posavski Podgajci, Račinovci, Rajevo Selo); C Vrbanja + D Vrbanja (Soljani, Strošinci); C Bošnjaci; C Štitar; C Babina Greda
Possible lines to the level B settlement - Vinkovci
D Vinkovci (Mirkovci); C Gradište; C Cerna + D Cerna (Šiškovci); C Andrijaševci + D Andrijaševci (Rokovci); C Otok + D Otok (Komletinci); C Privlaka; C Nijemci + D Nijemci (Apševci, Banovci, Donje Novo Selo, Đeletovci, Lipovac, Podgađe); C Stari Jnkovci + D Stari Jankovci (Novi Jankovci, Orolik, Slakovci, Srijemske Laze); C Stari Mikanovci + D Stari Mikanovci (Novi Mikanovci); C Vođinci; C Ivankovo + D Ivankovo (Prkovci, Retkovci); C Jarmina
Possible lines to the level A settlement - Vukovar
B Ilok; B Županja; B Vinkovci; D Vukovar (Lipovača, Sotin); C Tovarnik + D Tovarnik (Ilača), C Tompojevci + D Tompojevci (Berak, Čakovci, Mikluševci), C Lovas + D Lovas (Opatovac), C Negoslavci; C Markušica + D Markušica (Gaboš, Ostrovo); C Tordinci + D Tordinci (Antin, Korog); C Nuštar + D Nuštar (Cerić, Marinci); C Bogdanovci + D Bogdanovci (Petrovci, Svinjarevci); C Borovo; C Trpinja + D Trpinja (Bobota, Bršadin, Pačetin, Vera)

After graphical testing of the possible lines of public passenger transport and the confirmation of the possibility of organizing an optimal network, an overview in the form of a table was prepared (Table 3).

This also successfully completed the testing of the possibility of applying the proposed model for defining the minimum standards for public road passenger transport services based on easily accessible and reliable data sets.

5. Discussion

The analysis and evaluation of global and European experiences has shown that there is no generally accepted model for defining the minimum standards for the provision of public passenger transport services. The available models are mainly based on the pairing of the place of work/education and housing data. However, it was found that for most areas, there are no publicly available

data that are paired and usable, and for the application of these principles, very expensive and time-consuming fundamental transport research should be conducted.

Precisely in order to avoid the mentioned research, the purpose of this paper is to present one of the models for defining the minimum service standards in public road passenger transport on the basis of easily accessible and reliable data sets. The basic goal of the research was to propose a model based on easily accessible, reliable and public data sets. Furthermore, the aim was to propose a model that would meet the standards and modern European trends with the minimum fulfillment of the needs for movement through public passenger transport. The paper presents the basic framework for defining the minimum standards for services in public road passenger transport. The model is based on the functional structuring of settlements and the defining of a system of connections between settlements. It was developed as a basis for harmonizing and defining the preconditions of balanced regional development by ensuring an equal minimum level of transport accessibility to all areas. When defining the methodological framework, the valid EU regulation was taken into account and scientific and professional research on this topic was conducted. The basic determinant for quantifying the conditions was the existence of public statistics on the basis of which particular decisions are made and implemented.

The quality of the application of this methodology depends on the way of structuring the network of interregional, regional and local lines and their mutual integration. In order to successfully ensure qualitative accessibility of public transport in the coming period, it is necessary to ensure active implementation of integrated passenger transport through road, rail, but also sea and air transport.

The objectives of the research have been fully met and the possibility of applying the proposed model for defining the minimum standard for the provision of public passenger transport services in road transport has been proven on real examples.

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