



## THE ACCESSIBILITY OF RAIL TRANSPORT TO PEOPLE WITH REDUCED MOBILITY – CASE STUDY

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### Abstract

The means of rail transport as well as other modes of transport primarily enable people to easily overcome certain distances over a period of time. This implies the need for it to be adapted to such specificities, together with other elements in places where high concentrations of passengers are exchanged. This paper deals with a common problem of accessibility of rail transport to people with reduced mobility (PRM). PRM refers to people whose mobility is reduced due to physical incapacity, an intellectual deficiency, age, illness or any other cause of disability when using transport. Therefore, a thorough analysis of accessibility of rail transport to this group of passengers will be conducted for the city of Zagreb according to certain indicators. The rail station is considered to be accessible if a PRM passenger can enter passenger terminal, consume services available there and if is able to get to the platform from where the train will depart. The rolling stock is accessible if a PRM passenger can buy a ticket, enter the train and have predicted and available space in the train. By determining the real state of accessibility to PRM passengers of all railway stations and used rolling stock in suburban rail transit in the city of Zagreb, measures will be proposed to increase accessibility to these passengers and thus facilitate their integration into society in this segment and increase their quality of life.

*Keywords: people with reduced mobility, suburban rail transport, accessibility, case study*

### 1 Introduction

In the literature, there are various explanations of accessibility. Generally, it has been defined as some measure of spatial separation of human activities, representing the ease with which activities may be reached from a given location using a particular transportation system [1], [2]. Moreover, Litman interprets that when people say “location, location, location,” they really mean “accessibility, accessibility, accessibility” and that it refers to people’s ability to reach goods, services and activities, which is the ultimate goal of most transport activity [3]. According to him, accessibility can be defined in terms of potential (opportunities that could be reached) or in terms of activity (opportunities that are reached). Rietveld defined accessibility as the potential of opportunities for interaction based on both network features and the spatial distribution of activities. Since for each activity the relevant types of destinations are different, one may have to identify different accessibility indicators [4]. Mamun and Lownes described trip, spatial and temporal coverage as three primary components of accessibility, to which can be added an aspect that reflects comfort as a sufficient space available at the public transport at the time one wants to travel [5].

Once the accessibility is defined, the real question is in measurement of it [6]. One of the propositions for measuring public transport (PT) accessibility for European cities includes the population distribution and frequency of the service [7]. Authors defined five groups of accessibility, based on the access and departure frequency, from no access if people cannot easily walk and reach PT stop within 5 minutes (bus or tram) or 10 minutes (metro or rail) to very high access that provides more than 10 departures/h. The accessibility of public transport in Croatia, shown in Figure 1, was examined in a similar way. As can be seen, a good level of public transport availability is a key generator of mobility. This mostly applies to the metropolitan areas of Zagreb, Osijek, Rijeka and Split, where the highest number of daily migrations takes place. Compared to other considered cities, public transport in the wider area of the City of Zagreb is dominantly more developed. Given that its main backbones are the urban and suburban railways, the research of accessibility in this paper is focused on the urban railway of the City of Zagreb.

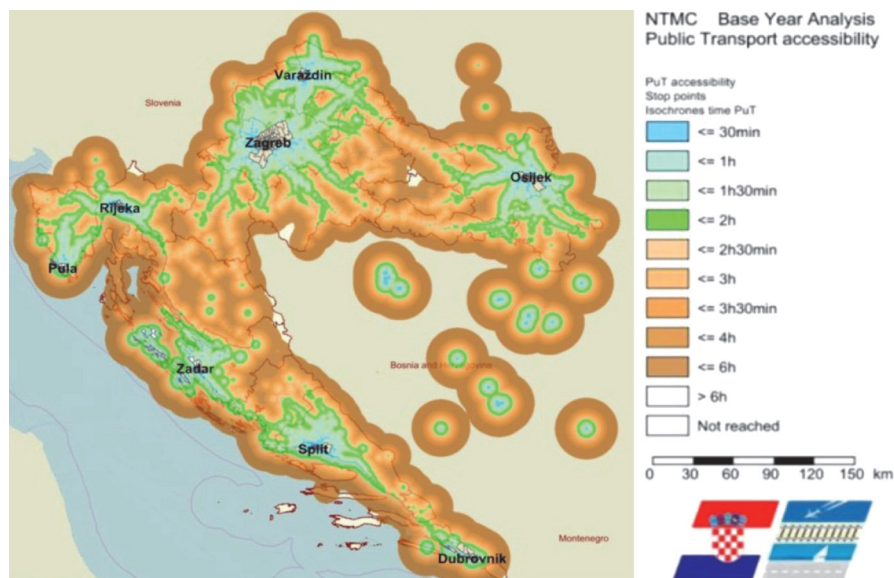


Figure 1 Public transport accessibility in Croatia, [8]

Railways, like any other PT, primarily integrate different social and economic needs, making themselves available to all potential users. However, shortcomings in accessibility to key integration points have the greatest impact on more vulnerable user groups such as people with reduced mobility (PRM). PRM refers to people whose mobility is temporary or permanent reduced due to physical incapacity, an intellectual deficiency, age, illness or any other cause of disability when using transport. Therefore, the following analysis of accessibility of rail transport, in terms of the current state of the infrastructure elements, rolling stock and organizational aspect, is considered from the aspect of PRM.

After this short introduction, the second chapter explains the chosen approach in data processing. This is followed by an analysis of the accessibility of urban rail transport for PRM in the city of Zagreb in the third chapter. The fourth chapter summarizes the proposals for its improvement, and the last one gives a final review of the obtained results and guidelines for future work.

## 2 Methodology

The area of the urban railway in this analysis covers a total of 6 stations and 12 stops. Among them, the largest is Zagreb Main Station with more than 2,6 million of passengers in 2018, while the following are Sesvete with 615 000 of passengers and Vrapče with 351 000 [9]. In order to facilitate the monitoring of the further course of analysis, these stations and stops are grouped according to the directions and main lines on which they are located. The borders of the selected routes are the last stations or stops that are within the administrative area of the city of Zagreb. According to the above, the analysis includes:

- direction towards Zaprešić: Zagreb Main Station, Zagreb West Station, Kustošija, Vrapče, Gajnice, Podsused;
- direction towards Dugo Selo: Maksimir, Trnava, Čulinec, Sesvete, Sesvetski Kraljevec;
- direction towards Karlovac: Remetinec, Hrvatski Leskovac, Horvati, Mavračići;
- direction towards Velika Gorica: Klara, Buzin and Odra.

Accessibility to rail transport in these selected points is analysed from several perspectives. On the one hand it is the accessibility to the station or stop from which the journey by rail begins or ends, and on the other the accessibility to the railway vehicle that allows the distance to be covered. In order to cover both of these aspects, the set of necessary elements has been determined. Their existence and condition will contribute to the formation of a detailed overview of the current availability of rail transport in Croatia to PRM. Those important for the availability of railway buildings are tactile tapes, wheelchair ramp on station entrance, necessary infrastructure elements that would enable PRM to reach all platforms, elevators, escalators, toilets for PRM, step-free access to the services at the station and voice and video information systems. Selected elements for accessibility in railway vehicles are floor height in relation to the platform, way of opening the door, wheelchair ramp at the train, dedicated place for wheelchair and toilets for PRM. Another important aspect is the way in which the service is adapted to PRM. Therefore, the ratio of low-floor trains to the total number of trains, possibility of assisting when passengers enter and exit the train and the existence of other benefits like more favorable transport prices were selected for the indicators. Once these elements and indicators were identified, field research was conducted. The collected data were then compiled for a synthesized review of the accessibility of railway service to people with reduced mobility in the city of Zagreb.

## 3 Analysis of accessibility of rail transport to PRM - case study Zagreb

The overall state of equipment of stations and stops with the necessary elements which ensure the accessibility of railway transport to PRM is shown in Table 1. Depending on the observed direction, the maximum number of a particular element of accessibility corresponds to the largest number of stations and stops located on a given route. It can be seen that the equipment of the stations and stops on route I, the one in the direction of Zaprešić, is significantly better than at the stations and stops on other routes, although the condition of equipment is not in a completely satisfactory in all passenger buildings.

**Table 1** Overview of the elements of accessibility at passenger buildings

Element	Presence of elements in stations/stops per maximum in each direction			
	I (max. 6)	II (max. 5)	III (max. 4)	IV (max. 3)
Tactile tapes	3	0	0	1
Wheelchair ramp on station entrance	4	1	0	2
Step-free access to the services at the station	6	5	0	0
Infrastructure elements to reach all platforms	4	3	1	1
Elevator	3	0	0	1
Escalator	0	0	0	0
Toilets for PRM	1	0	0	1
Video information system about timetable and delays	1	0	0	0
Voice information system about timetable and delays	4	1	1	1

A wheelchair ramp is one of the most important elements that would enable PRM to access the station/stop. On the line towards Zaprešić, only Podsused and Zagreb West Station do not have ramp. Other stops have it and their overall condition is good. On the line towards Dugo Selo, ramp is placed only in stop Sesvetski Kraljevec, while on the line towards Karlovac there is none. Odra and Buzin on the line towards Velika Gorica both have ramps which are in excellent condition. Buzin also has an elevator in excellent condition. This is a good substitute for the lack of a ramp, as is the case with elevator in Podsused, which is in the same condition as previous. However, two other elevators on the same line, in Gajnice and Vrapče, are not in the function. Also, no escalator is applied anywhere in the area under consideration. Once the user is in the terminal, it is necessary to enable step-free access to all services that terminal provides (shops, ticket, etc.). This condition is best met by passenger buildings on the route to Zaprešić, and otherwise to Dugo Selo. It is not surprising since this is where the busiest line of urban and suburban rail transport runs. However, if the infrastructural elements for accessing the platforms are observed, the situation is worse. Zagreb Main Station and Zagreb West Station on I. direction, Maksimir and Čulinec on the II., Horvati, Remetinec and Hrvatski Leskovac on the III. and Odra and Klara on the IV. direction do not meet this condition. In terms of existence of toilets for PRM, they are only in Zagreb Main Station and Buzin, but the one in Buzin is not functional. Tactile straps significantly facilitate the orientation and movement of passengers. Unfortunately, guidance with their help is possible only in Buzin, Gajnice, Vrapče and Podsused. Informing passengers about stable and changing data can generally be done visually (video) or by voice. Stable data refer to, for example, timetables and travel directions, while variable data are often delays. Most of the observed passenger buildings do not have any of these systems, or if do, they are in poor condition or not working like those in Vrapče, Gajnice and Podsused. On the contrary, voice information for passengers is excellent in Sesvete, Hrvatski Leskovac and Buzin. Video informing is available only in Zagreb Main Station.

Urban and suburban rail transport of the city of Zagreb uses different electric multiple units (EMU). There are two basic types, the older trains HŽ 6111 and the newer HŽ 6112. From the point of view of accessibility, the main difference between them is in the height of the floor in relation to the platforms and in the interior of the train. Older EMU trains have stairs at the entrance and are not adapted to PRM, while newer ones are low-floor and equipped

with wheelchair ramps. In addition to the above, the newer trains have a wider front door, a dedicated wheelchair space and a custom toilet. In older versions, the doors open and close automatically, while in newer versions they open by pressing a visually and tactilely highlighted button. Besides the above, classic train compositions with locomotives and wagons, powered by both electric and diesel, as well as diesel multiple units (DMU) intended for regional and international needs, also participate in the provision of railway services in selected area. While different versions of the DMU are similar to the previously described EMUs in terms of accessibility, the difference in the types of passenger wagons used is significant in the classic compositions. They are usually not equipped with special ramps, have a narrow and stepped entrance and narrow toilets and passages between the seats without a special place for wheelchairs. To open the door, you need to turn the lever manually or press a button, which also varies.

If observing the proportion of low-floor trains, with respect to all passenger trains (excluding fast and IC trains) that operate on the considered sections, most newer EMUs and DMUs are in use on the section towards Zaprešić (79 %), then towards Velika Gorica (74.3 %) and Dugo Selo (63.6 %), while the least is towards Karlovac (26.5 %), [10]. Moreover, regarding the organizational aspect of PRM transportation by rail, it is necessary to announce the planned journey at latest 48 hours in advance. In that case, the employees of the infrastructure manager and the operator assist while entering/exiting the train free of charge. However, this solution is not the most convenient because it restricts the user's freedom in choosing travel time. On the other side, national passenger operator HŽ Putnički prijevoz offers two types of benefits in the form of smart cards for users in PRM category, [11]. Firstly, all Croatian pensioners and persons over the age of 60 are entitled to an annual 50 % discount on domestic rail travel. Secondly, persons with disabilities are allowed four journeys a year with a 75 % discount from the regular transport price in the 1st or 2nd class of passenger and fast train, while their companions receive a 100 % discount. A special category consists of military and civilian war invalids who have one free journey per year, in 1st and 2nd class passenger or fast train, to visit the grave of the deceased or four journeys per year with 75 % discount from regular transport fares in 1st or 2nd class passenger or fast train. Their companions also receive a 100 % discount. Furthermore, members of the Croatian Association of the Blind and the Croatian Association of Deafblind People DODIR and one accompanying person receive a discount of 50 % on all regular trains in domestic traffic. Members of the Association of Disabled Workers of Zagreb are entitled to a discount of 50 % if they are retired and unemployed, or 30 % if they are employed, but at distances greater than 25 km.

## 4 Increase of accessibility of rail system

At the level of the European Union (EU), access to platforms, stations, rolling stocks and other facilities that railway undertakers and station managers should provide to PRM is regulated by regulation No 1371/2007 of the European Parliament and the Council (article 21) and accompanying Commission Regulation (EU) No 1300/2014 Technical specifications for interoperability (TSI) for PRM [12], [13]. Furthermore, regulation of this issue at the national level relies directly on this TSI, as Croatia adopted the PRM National Implementation Plan (NIP) in 2017.

The point 4.2.1 in the PRM TSI describes functional and technical specifications of the infrastructure subsystem related to accessibility for persons with disabilities and PRM. Table 2 shows the results of the analysis of the condition of stations and stops in Croatia according to the mentioned requirements. As can be seen only 8 % of stations and stops in Croatia met at least 50 % of the PRM accessibility requirements. The plan is to modernize 109 stops and stations in the next 10 to 15 years in order to meet all the requirements of point 4.2.1 of the PRM TSI. Apart from that, it is planned to meet some requirements on additional 58 stops and stations.

**Table 2** Condition of stops and stations based on the 4.2.1 point of PRM TSI, [14]

State of stations and stops	All requirements fulfilled	More than 80 % requirements fulfilled	50 % requirements fulfilled	Requirements slightly met
No. of stops and stations	4	13	18	391

Similarly, the following section 4.2.2 in the PRM TSI defines the requirements for rolling stocks. The results for Croatia are presented in Table 3 where is seen that 73 % of multiple units are not compliant with the TSI for PRM and that will not change in the near future.

**Table 3** Passenger rolling stock condition based on the 4.2.2 point of PRM TSI, [14]

Rolling stock	TSI PRM requirements met/planned condition for the 2020	TSI PRM partially met/ planned condition for the 2020	Without PRM TSI requirements/ planned condition for the 2020
Multiple units	24/47	6/6	82/82
Wagons	2/2	/	209/108

Plans for the improvement of the existing infrastructure in the PRM NIP are within reconstruction and modernization projects of Croatian railway network in general, and without a systematic approach in targeted removal of accessibility barriers. Since the directions discussed here are currently part of the projects in the stages of preparation of study documentation and design, and due to the nature of the following stages, their implementation cannot be expected in the next few years. The authors of this paper believe that more urgent actions are necessary in order to improve access for the PRM. The improvement of the basic elements on the infrastructure subsystem should not be linked to the projects to be funded in the next 10 to 15 years. Since 30 % of all transported passengers by rail are in City of Zagreb [9], infrastructure manager together with the city government should pay more attention to the real needs of users and consider numerous recommendations from a European and national basis to increase access to the rail transport for all groups of users, including the PRM. This would set a high scale for the quality of public transport in the Croatian capital.

At the same time as increasing the accessibility of infrastructure, railway operator should continue to work on renewal of the available rolling stock and introduction of low-floor trains structurally adapted to all user groups. This refers not only to the fleet used in the urban area discussed in this article, but also to the rest of the network where the classic train compositions are still primarily used, which makes the access conditions to PRM even more difficult. Therefore, it is important to introduce at least one pair of low-floor train on regional and local lines. On the lines where that will not be possible, due to the number of available trains, operator and station manager must ensure access for the PRM using other resources like mobile ramps.

## 5 Conclusion

The analysis of the accessibility of urban railway transport to the PRM showed the poor condition of the identified elements of accessibility of stations and stops in the area of the Croatian capital. A large number of them are not adequately equipped at all, or if certain elements do exist, it is likely that they are not in function, making them direct obstacles to the accessibility of rail to the PRM. An additional problem in the organization and realization of the transport process is the unfit interior of a large number of trains, and for access to which

PRMs must be announced 2 days in advance if want help. This despite financial benefits significantly limits their more frequent use. The recommendation is the joint implementation of existing national plans to increase accessibility for people with reduced mobility in terms of infrastructure and vehicles so that the entire rail transport service is barrier-free for this and all other categories of users. This analysis covered a small proportion of total rail network in Croatia, and future work should consider the accessibility of rail transport on the entire network in order to obtain a complete state and make more effective recommendations.

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