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MODEL OF TRAFFIC ACCESS MODE AND RAILWAY STATION CHOICE OF SUBURBAN RAILWAY SYSTEM IN SLOVENIA

Summary. This article presents the establishment of a model of understanding the access mode and railway station choice of Slovenian passengers. Therefore, a model has been designed to predict the determination of existing decision making preferences of railway users about the access mode and railway station choice with a stated preference survey and face to face method. The target group in the survey were railway passengers in the suburban environment that use the rail for work and school purposes. The total number of respondents was 412. The survey showed that most passengers access the railway station with car (60,2%), by foot (26,2%), with public transport (bus – 8,3%) and with bike (5,3%). Average distance to the station is 4,9 km, average time of access is 10,5 min. Upon exit most passengers walk to the final destination (84,5%), use the public transport (bus – 14,1%), car (1,2%) or bike (0,2%). Average time from exit of the train to final destination is 13,1 min, average distance is 1,58 km.

DAS MODELL DER AUSWAHL DES ZUTRITTES UND DER BAHNSTATION IN SUBURBANEM BAHNSYSTEM IN SLOWENIEN

Zusammenfassung. Der Artikel präsentiert die Errichtung von einem Modell für Darstellung von Auswahl des Zutrittes und der Bahnstation von Passagieren in Slowenien. Dafür wurde ein Modell errichtet, der die vorhandenen Entscheidungen von Bahnpassagieren in den Bereich von Auswahl des Zutrittes und der Bahnstation prognostiziert aufgrund einer Umfrage und „von Angesicht zu Angesicht“ Methode. Die Zielgruppe der Umfrage waren Bahnpassagiere in einer suburbanen Umgebung die die Bahn benutzen um in die Schule oder zur Arbeit zu fahren. Teilgenommen haben 412 Bahnbenutzer. Die Umfrage hat gezeigt, dass die meisten Passagiere zum Bahnhof mit einem Auto fahren (60,2%), zur Fuß (26,2%) oder mit öffentlichen Verkehrsmitteln kommen (Bus – 8,3%) oder mit einem Fahrrad (5,3%). Der durchschnittliche Abstand zur Bahnstation ist 4,9 km, die durchschnittliche Zugang Zeit ist 10,5 min. Beim Austritt von der Bahn gehen die meisten Passagiere zu dem Endpunkt der Reise zu Fuß (84,5%), mit öffentlichen Verkehrsmitteln (Bus 14,1%), mit einem Auto (1,2%) oder mit einem Fahrrad (0,2%). Die durchschnittliche Zeit von der Bahnstation zum Endpunkt ist 13,1 min, die durchschnittliche Distanz 1,58 km.

1. INTRODUCTION

Investments in public infrastructure present a big financial challenge for the investor (i.e. the country), especially in a time of economic crisis. It is therefore necessary to consider all possible consequences of each action of investments in the public railway infrastructure. Therefore it is necessary to examine all the relevant characteristics of traffic flows modeling methodologies, technical-technological and exploitation features of railway subsystem and analyze existing subsystems of public transport.

Analysis of the Statistical Office of the Republic of Slovenia (SORS further) show a lower demand for public railway passenger transport, trend of growth of motorization and increasing consumption of energy in transport and overloading of road infrastructure. This leads to the conclusion that the full range of passenger transport is developing in environmentally problematic direction because of the rapid growth of private car use. In 2011, the internal rail carried more than 14.8 million passengers. According to the 2010 this number in national transport decreased by 3%, and in international transport by 2%, to 905-thousand. In 2012, 773 million total passenger-kilometres were made in national and international transport, which is 5% less than in 2010. 641 million passenger-kilometers were conducted in national transport, which presents a 5.6% decline and 83% of total passenger-kilometres [18].

These are clear indications that urgent actions are needed to provide measures to increase the attractiveness of public passenger rail transport.

The main purpose of the article is to provide a methodological model for the determination of the method of access to the railway station and the station choice of passengers. The findings of the research can be used to determine the effects of infrastructure measures of public passenger railway transport and beyond.

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2. SURVEY RESULTS STUDY OF RAILWAY STATION SELECTION

A number of foreign studies in the field of transport planning state various factors that affect the access mode and railway station choice.

Ortúzar and Willumsen (2011) note that three groups of factors affect the choice of means of transport and consequently the choice of station. In the first group they placed the characteristics of the travellers (the ownership of a vehicle, the possession of a driver's license, income, household structure, density of population), in the second group the characteristics of journeys (the purpose of the travel, the time in the day of trips, individual or group travel), and in the third group the characteristics of means of transport (quantitative factor: time of travel, travel cost, accessibility, parking; qualitative factors such as convenience, reliability, punctuality, safety and the possibility of additional activities in the time of travelling, for example reading) [1].

Debrezion and others (2007), in a study of accessibility of railway stations in the Netherlands, determined access modes and the choice of stations in the country. The study assumed that passengers have already chosen the train as their means of transport. They used a hierarchical or too structure logit model (nestet logit model). On the basis of the utility-maximizing method they evaluated factors that affect the access mode and choice of railway station. As a negative factor in the choice of railway transport they highlighted the uneven size of gravitational areas of stations which affects the choice of access mode. The survey showed that most of the rail transport users' access to stations on foot or by bike. In the case of a larger gravitational areas of the station the passengers are distributed between other means of transport (car or other forms of public transport - bus). As a positive factor in the choice of railway transport they highlighted the possibility of parking areas for cars and bicycles. The frequency of the transport has a positive effect while the travel time to the station has a negative effect on the choice of the departure station. An important indicator of the choice of railway station is the quality of rail transport (rail service quality index – RSQI). Furthermore, they established that the average distance between stations in the country is 7 km, in urban and suburban traffic 3.5 km. Railway transport is most used for longer distances (the average length of trip amounts to 40 km) [7].

Most of the studies of accessibility of railway stations are derived from the findings of the study of accessibility of airports (Psaraki and Abacoumkin, 2002; Basar and Bhat, 2004; Hess and P, 2005), where the multimodal logit model is used to determine the method of choosing the airports [2, 6, 10].

Debrezion and others (2007) determine that accessibility to rail stations is different from accessibility to bus stations in the urban and suburban traffic. They observed that users in Netherlands are likely to walk to the railway stations a distance of about 1.1 km and by bicycle ride a distance up to 4.2 km. Guan and colleagues (2009, 55) came to the conclusion that the best accessible distance to the railway station is less than 1,500 meters [12].

3. THEORETICAL STARTING POINT

When deciding to travel by rail, we have to answer two key questions: which entry station to choose and how to access to this station.

The answers are influenced by various factors. Ortúzar and Willumsen (2011) refer to three groups of factors [1]:

1) the characteristics of the traveller,
2) the characteristics of the journey and
3) the characteristics of the available alternatives.

The choice of the outgoing station is affected by two kinds of factors: factors related to accessibility to the station and the factors related to the quality of the station. The quality of the station is defined by the quality of the rail (speed, frequency, coverage) and the complementary services at the station (parking, bike racks, P + R system, feeding items) [7].

Part of the area, where residents can use a certain line of public transport, represents an influential or gravitational area of this line. The influential area is determined with the rectangular distance to the line, from where passengers usually still walk to the station. A number of studies show (Schnabel and Lohse, 2011; Halden with colleagues, 2005) that the influential area in the city center is from 300 to 400 m, on the outskirts of the city from 400 to 500 m and out of the city from 500 to 1000 m [5, 13].

Passengers walking time to the station is one of the most important factors when planning the locations of stations. We proceed from the idea that the direct distance between two points is the shortest path, and that the actual pedestrian path is longer. Schnabel and Lohse (2011) note that the average speed of travel for pedestrians is 4,2 km/h, for cyclists 12 km/h, for public transport users 18 km/h and for car users 30 km/h [4].

Table 1

Walking distance from home to station

Type of travel	Time (and distance)
Walking from home to final destination	20 min (distance from 1,4 to 1,6 km)
Walking to bus station in the city	5 min (distance from 300 to 500 m)
Walking to bus station outside the city	10 min (distance from 600 to 1000 m)
Walking to railway station	10 min (distance from 600 to 1000 m)

Source: [13]

Halden with colleagues (2005) has noted (table 1), that on average a passenger is willing to walk from home to final destination 20 minutes (distance from 1,4 to 1,6 km), from home to the bus station 5 minutes (distance from 300 to 500 m) or in the rural environment 10 minutes (distance from 600 to 1000 m) and from home to the railway station 10 minutes (distance from 600 to 1000 m) [13].

Modelling the spatial accessibility of a station is possible with analysis of influential areas (buffer analysis), which works by drawing a ring with specific radius (r) around the station, in order to determine the service/influential area within air distance from the station.

Accessibility is then calculated as the ratio between the number of inhabitants within so obtained intermediate zone and the total number of inhabitants in the selected spatial unit [4, 14].

The second method is the analysis of the actual distance from the stations and origins from the network ratio method. Its use is based on network analysis, where the isolines of the same spatial or temporal distance are determined on the basis of the actual distance from the station on a street or road network. In this method the spatial accessibility is calculated as the ratio between the total length of streets, distant for a given spatial distance on the network, and the entire length of the streets in the spatial unit. Instead of the ratio between the lengths of streets in this method we can use the ratio between the number of centroid buildings or ratio between number of inhabitants [4, 14].

Most commonly used models for the prediction of passenger behaviour are models of discrete choice. This models predict an individual's choice in the form of functions of any number of variables and constants. If an individual has to choose between two possible departure stations there are K alternative choices which we combine into J subgroups (loops-nests). Each subgroup J has Nj alternatives. The final choice is possible through a combination of options for both alternatives. The usefulness j for an individual, who decides to choose the k departure station, can be written using the following equation [1]:

$$\mathrm{U}_{\mathrm{jk}} = \mathrm{V}_{\mathrm{jk}} + \varepsilon_{\mathrm{jk}} \tag{1}$$

where with V_{jk} we refer to the deterministic part of the applicable economic function. ε_{jk} presents random error. If we select nested logit model from the model group GEV (generalized extreme value), which is likely to choose alternative k among a set of alternatives K, the equation follows [1]:

$$P_{k|j} = \frac{\exp(\mu_j V_{k|j})}{\sum_{l \in K_j} \mu_j V_{l|j}} = \frac{\exp(\mu_j \boldsymbol{\beta}' \mathrm{x}_{k|j})}{\sum_{l \in K_j} \exp(\mu_j \boldsymbol{\beta}' \mathrm{x}_{l|j})} \tag{2}$$

$$P_j = \frac{\exp(\widetilde{V}_j)}{\sum_{m \in J} \exp(\widetilde{V}_m)} = \frac{\exp(\boldsymbol{\gamma}' \mathrm{y}_j + 1/\mu_j (\ln(\sum_{k \in K_j} \exp(\mu_j \boldsymbol{\beta}' \mathrm{x}_{k|j}))))}{\sum_{m \in J} \exp(\boldsymbol{\gamma}' \mathrm{y}_m + 1/\mu_m (\ln(\sum_{m \in M_j} \exp(\mu_j \boldsymbol{\beta}' \mathrm{x}_{m|j}))))} \tag{3}$$

where x_i notes the vector of the explanatory variables of station choice, β' represents the vector of coefficients, which is specific for each of the alternatives of station choice. μ_i represents the parameter for the homogeneity and is with the RU2 model (random utility maximization theory) greater than 1 [1].

4. METHODOLOGY

With the methodological model for passenger access to the station and the choice of departure station we want to explore the decision making process of Slovenian passengers depending on the access method to the departure station and the choice of station. Understanding the decision-making factors that affect the choice of the departure station, and the way to access it, has more practical implications for the development of management policy of passenger transport for urban, suburban and intercity transport. It allows us to define influence areas of stations. This means that it improves forecasts of requirements/demands for trips at the station level. This can be used as a basis for selecting sites for developing new stations or planning of extensions for existing lines as well as parking options (P + R) and the design of the power supply (feeder) public transport lines.

We will present two methodological models to determine accessibility to railway stations and stops.

To decide on the entry station and access mode we will use the nestet logit model (NL). Passengers are assumed to have already chosen the train as their means of transport.

Submodel of choice accessibility of the station is dealing with the problem of the choice of paths to the destination. The route from the origin of the journey to departure station is called access, the route from the exit station to the final destination of travel is called egress.

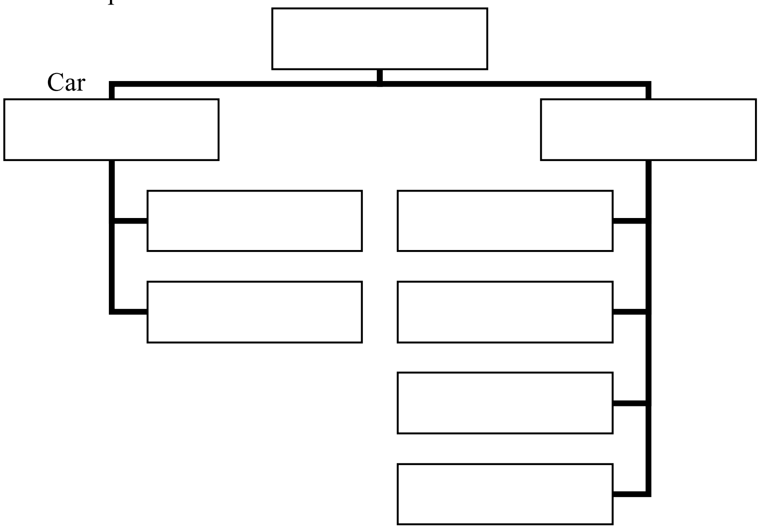

Fig. 1. Station choice model
Abb. 1. Das Modell der Auswahl des Zutrittes

The choice of the departure station is affected with two types of factors: factors related to accessibility to the station, and factors associated with the services that are available at the station. Factors of accessibility to the stations are:

- the distance to the station,
- travel time to the station and
- the cost of the access.

Factors associated with quality of the station are:

- frequency,
- possibility of bicycle parking,
- possibility of vehicle parking,
- park and ride (P + R) system and
- train travel time.

For clarification of decisions, made by individuals, we took into consideration the ownership of a private vehicle, the possession of driver's licenses and the type of ticket.

The data for the implementation of the model were obtained from a survey on the preferences expressed by the method of direct interview.

5. RESULTS OF THE SURVEY

For the understanding of the travel habits of individuals and the factors that affect the use of rail transport, we conducted a survey in the month of May 2013 about the mode of access and station choice of railway users. The method used was a direct interview with passengers at stations (face to face) by the method of expressed preferences (stated preference survey). The target group were passengers who embark on the train at the stations Poljčane, Slovenska Bistrica and Pragersko and exiting at the station Maribor/Maribor Tezno. The total number of respondents was N = 412.

For the purpose of the research we set certain assumptions and limitations, which are necessary for understanding decisions of railway users about their access mode and station choice in suburban rail transport in Slovenia. The basic limitations and assumptions are:

- The spatial limitations: we conducted the survey in the suburban area in Podravje region, on the stations Poljčane, Slovenska Bistrica and Pragersko.
- Time limitations: the survey was conducted for three weeks, from Tuesday to Friday between 6 am and 9 am. Interviewing began on 14th of May 2013.
- Data for the study were obtained with expressed preference survey, which was carried out at stations with the method of direct interviewing of passengers. In interviewing three interviewers were included (at each station one).
- We interviewed only passengers who travelled in the direction of the Maribor station. In doing so, it was necessary to ensure the representativeness of the final sample of passengers depending on gender, age and purpose of travel. Together N = 412 surveys were conducted.

The survey was divided into two parts. In the first part we obtained data on the socio-economic status (age, gender, the ownership of the vehicle, a driver's license possession) and trip (origin, way of access, access time, the distance from home to the station, the cost of access and waiting time for the train). Due to the economic situation in Slovenia we did not question passengers on their employment status (employed/unemployed, a student) and education, whereas in the test survey results proved that the passengers did not like to answer such questions. These data were assessed through other indirect factors, such as the ownership of the vehicle, the purpose of the trip, and the frequency of travel, ticket type and age. In the second part of the survey, we asked the passengers two hypothetical questions.

Respondents were divided into five age groups. The greatest number of train users are in the age group of up to 24 years, these are pupils and students (63,1%), followed by the passengers between the ages of 25 and 54 (29,9%). The lowest share have the passengers above the age of 55 (7,1%). The total number of respondents was 412.

From the 412 respondents the purpose of the journey was school in 266 cases (64,6 %), job in 87 cases (21,1%) and other (shopping, leisure, ...) in 59 cases (14,3%).

The most common way to access the station (Fig. 2) is by car (as driver or passenger) (60,2%), followed by walking (26.2%), public transport (8,3%) and bicycle (5,3%).

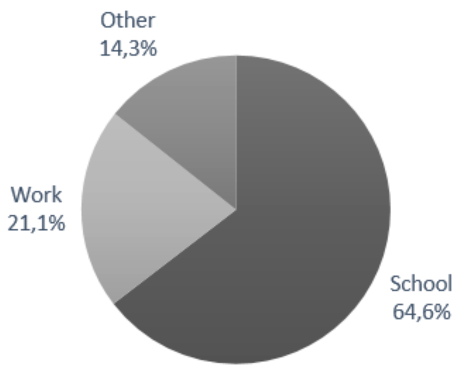

Fig. 2. Share of passengers by purpose of travel
Abb. 2. Anteil der Passagiere aufgrund des Reisezweckes

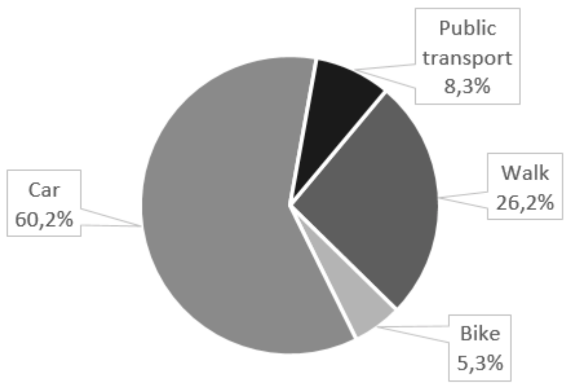

Fig. 3. Share of modal split with access to the station
Abb. 3. Anteil des „modal Split“ aufgrund des Zutrittes zur Bahnstation

Passengers in the age group to 24 years are most commonly to come to the station as passengers in a personal vehicle (46,5%), walking (18,8%), as drivers of private vehicles (17,3%), by bike (6,5%) or public transport (10,8%). We concluded that the share of integrated public passenger transport (bus, train) is at a very low level because the connectivity between modalities on the stations of Poljčane, Slovenska Bistrica and Pragersko are very bad, as we will talk about below.

With detailed overview of the access methods for stations Poljčane, Slovenska Bistrica and Pragersko we can conclude that chosen modalities of the access is heavily dependent on the position of the station in the area (in or out of urban environment) and other factors (e.g., the link train-bus). Stations Poljčane and Pragersko are situated in urban environment, while Slovenska Bistrica is not.

Slovenska Bistrica station is distant from the settlements Slovenska Bistrica (4,1 km), Laporje (2,3 km), Črešnjevec (2,4 km), etc., so the largest proportion of the modal split goes by car (77,7%), followed by public transport with 11,7%.

Motorcycle and moped occupy a negligible share of access mode to the station, therefore we joined the mopeds to modality bike and motorcycle to modality car.

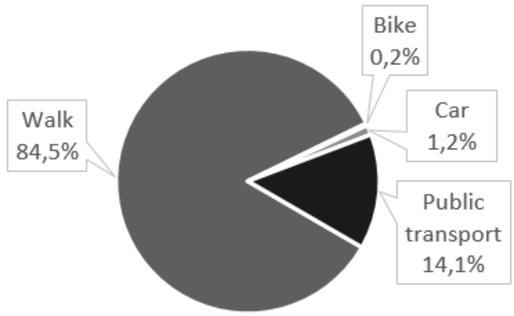

Fig. 4. Choice of means of transport after exiting the train
Abb. 4. Die Auswahl des Transportmittels bei Austritt von der Bahn

Obtained data on the choice of means of transport after exiting the train shows that most passengers (84,5%) reach the final destination on foot, 14,1% re use the public transport (bus or taxi), the share of other forms is negligible (fig. 4).

In the fig. 5 average times of access (in minutes) to the train station and the average distance from home to the station (in km) are presented. We find that the average access time to the station is 10.5 minutes and the average distance from home to the station is 4.9 km. At the exit from the train average travel time to the final destination is 13.1 minutes, average distance 1,58 km. Average time of waiting at the entrance station is 7.9 minutes.

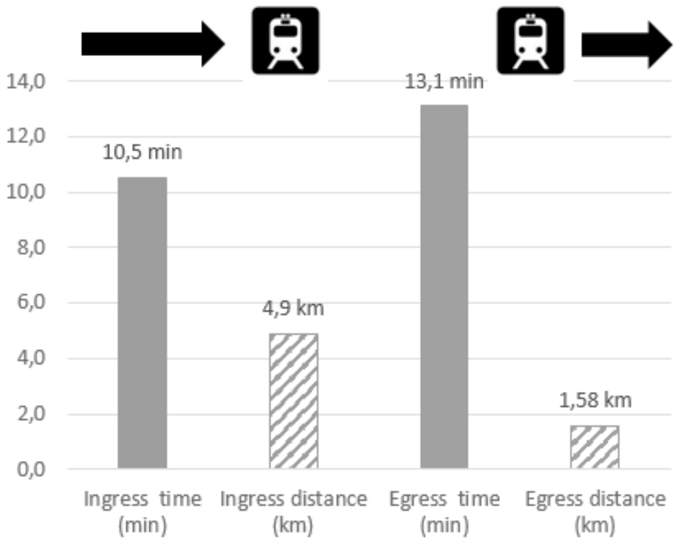

Fig. 5. Average access time/egress time and performed route to/from station
Abb. 5. Die durchschnittliche Zeit bei zutritt/austritt und der Distanz zu/von der Bahnstation

A detailed analysis of time of access and distance from home to the departure station by means of transport shows that passengers that walk require the least amount of time (9,3 min), their average distance to the station is 820 m.

Table 2

Time and distance of access by means of transport

Modal split	Access to station in min					Distance from home to station (km)				
	N	Average (min)	Standard deviation	Min.	Max.	N	Average (km)	Standard deviation	Min.	Max.
Walk	108	9,3	4,81	2,0	20,0	108	0,82	0,40	0,10	2,0
Bike	22	11,0	3,98	4,0	17,0	22	2,20	0,77	0,80	3,40
Car	248	10,5	5,66	2,0	30,0	248	6,76	4,30	1,10	22,0
Public transport	34	14,2	4,81	8,0	20,0	34	6,13	2,62	2,30	9,70
Total	**412**	**10,54**	**5,45**	**2,0**	**30,0**	**412**	**4,90**	**4,33**	**0,1**	**22,0**

Users of public transport (ie. bus) are statistically different from other modalities, because they need 14,2 min to the station with average distance of 6,13 km.

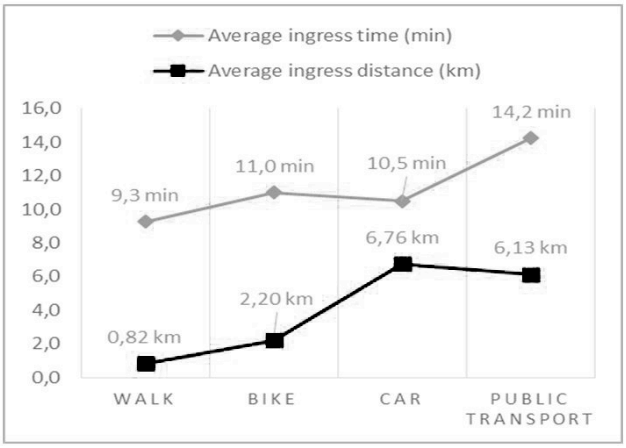

Fig. 6. Graphical presentation of access time and distance
Abb. 6. Grafische Präsentation von zutritt Zeit und Distanz

This added to that the waiting time at the station, public transport users are forced to wait an average of 9.7 minutes for the train. The standard deviation of waiting for public transport users is 2.24 min, which indicates that the timetables (train - bus) must be better coordinated .

We asked the respondents about the quality factors (table 3) of the station. We evaluated factors on a scale from 1 to 5, where 1 means very poor quality and 5 excellent quality. Certain factors are evaluated by all respondents (N = 412), while car parking possibilities were judged only by respondents who came to the station by car, parking of bicycles was judged by pedestrians and cyclists and the coordination of timetables bus/train was judged by public transport users.

Accessibility to the station was rated good (3.6) with standard deviation of 0.99. The accessibility to the station was best rated by pedestrians (4.4) and the worst by users of public transport (2.8). Poor assessment of the accessibility of public transport users is due to prolonged access to the station, which is longer than with other modalities (Fig. 6) and amounts to 14.2 minutes.

Orderliness of rail stations is estimated with an average score of 3.1, which is surprising, considering that the stations are out of date and in need of restoration. This shows that the orderliness of stations is not very important to rail users, and that they give priority to other attributes of the station, such as parking possibilities for vehicles and the frequency of the trains.

Users of the train assessed the frequency of trains (the number of minutes between two sequential arriving trains between 6 am and 10 pm) with an average rating of 3,5 (N = 412). The best estimated was the frequency at the stations Poljčane (3,7) and Pragersko (3,5), the worst being Slovenska Bistrica station (3,1). Such assessment is the consequence of better frequency of trains than Slovenska Bistrica (Poljčane 44 min, Pragersko 28 min.) It is interesting to note that, in spite of better frequency at Pragersko station, the rating is similar as on Poljčane station, which is likely to be attributed to the proximity to Maribor station and the possibility of using alternative routes via highway with a car.

The possibility of parking the vehicles at the stations (N = 248) is estimated as well (3,4), although the passengers did suggest that the parking lots should be improved (asphalt surfacing) and better prepared for winter.

The possibility of parking bikes (N = 130) is evaluated as bad (2,2) with a standard deviation of 0,87. The respondents negatively evaluated only the maintenance of bicycle sheds, because they are neglected (trash), in summer often overgrown with nettles (stations Pragersko and Poljčane).

Bus users (N = 34) were to assess the consistency of the schedules at the crossing of the train with the bus (3,1), whereby the worst evaluated was station Slovenska Bistrica (2.9), for the station Pragersko, however, there has been no user.

6. HYPOTHETICAL SITUATIONS OF ACCESS MODE AND RAILWAY STATION CHOICE

In the second part of the survey respondents were presented with two hypothetical situations in order to determine the impact of preferences on the access method and the station choice in suburban environment of the Podravje region.

By observing the preferences of train users we have to consider certain restrictions that are associated with the actual decision about traveling by train, affected by a number of factors (e.g., access time, frequency, cost) that are interrelated. It is therefore difficult to predict their exact purpose in the model and with that forecasting. With the first part of the survey we determined which factors are more or less important when choosing a mode of access and deciding on the train station. Important factors are: distance, time of access, the frequency and generalized travel costs. Less important are: disorder of station, parking of cars and bikes, crossing possibilities.

Respondents were staged with two hypothetical situation and had to select the most attractive one or none.

Q***uestion 1: Which station would you choose if the train frequency at the nearest station increases by 50%?***

We previously explained to the respondents that the frequency of the trains in Poljčane is 44 min, in Slovenska Bistrica 50 min and in Pragersko 28 min (the number of minutes between two sequential arriving trains between 6 am and 10 pm).

Table 3

The results of the stations choice at different frequency of trains

Station	N	Poljčane		Slovenska Bistrica		Pragersko	
		N_1	Difference (%)	N_2	Difference (%)	N_3	Difference (%)
Poljčane	185	169	-8,6%	16	8,6%	0	0,0%
Slovenska Bistrica	103	5	4,6%	94	-8,5%	4	3,9%
Pragersko	124	0	0,0%	2	1,6%	122	1,6%
Total	412	174	-5,9%	112	8,7%	126	1,6%

In table 3 we presented the change of frequency factor for the stations Poljčane, Slovenska Bistrica and Pragersko. For the stations Poljčane and Slovenska Bistrica the frequency improves (-50%), for the station Pragersko it degrades (+ 50%). We predict that improvement in the frequency would have a positive effect on the choice of entry station, primarily for passengers that use cars and public transport as existing method of access.

We find that improving the frequency of trains (the number of minutes between two sequential arriving trains for 50%) impacts the choice of entry station, but the effects are not as big as we had initially expected (table 3). In the case of improving the frequency of trains at the station Slovenska Bistrica by 50%, the number of incoming passengers at station Poljčane reduces by 5.9%, but increases in Slovenska Bistrica by 8,7%. Pragersko already has the best train frequency among above mentioned stations, therefore we increased it by 50% (56 minutes). We found that only 1,6% of passengers would change their current entry station. An explanation can be found in a number of factors, such as the current distance from home to the station, time of train journeys, the possibility of vehicle parking, cheaper tickets and the use of ICS trains, which do not hold on the stations Slovenska Bistrica and Poljčane.

Question 2: Which means of transport, in addition to the one currently used, would you choose, if additional benefits/advantages could be provided?

Respondents had to choose one of the options given in table 4.

Table 4

The choice of alternatives in hypothetical situation 2

Alternative A	Alternative B	Alternative C
PUBLIC TRANSPORT (bus) - a coordinated timetable at crossing - single ticket (bus, train) with a 50% discount on the price of the train ticket	**Bike** - bike storage with a roof	**Access method remains unchanged**

Because we want to encourage the use of public transport (bus-train integration), in alternative A we offered a coordinated timetable at crossing, and a single ticket for bus and train, with the fact that passengers have an additional 50 % discount on the price of the train ticket. In doing so we have ruled out existing users of public transport (bus) for the credibility of the data.

Alternative B is a bike storage room, protected by a roof. We already established that train users poorly evaluated the possibility of parking. We have to take into account that the use of bicycles in Slovenia is increasing.

Results of the survey shows that the offered alternative A, i.e. a coordinated bus/train timetable for crossing and the single ticket for bus and train, with an additional 50% discount on the price of the train ticket, have a positive impact on the change in the method of access. 20.4% of passengers would walk to the station (26.2% actually, difference -5.8%), and 17% would ride in with a bicycle 17.0% (5.3% actually, difference 11.7%), 39.3% would use the car (60.2% actually, difference -20.9%), and 23,3% would use public transport (8.3% actually, difference 15%). The maximum displacement of passengers is from using a personal vehicle (20,9%) to using public transport (bus-train), which is statistically possible, given that currently 34% of all respondents (N = 412) arrive to the station as passengers in personal vehicles. We can claim that coordinated, tactful transport (bus, train) would improve the use of public transport.

Surprisingly, the share of passengers that arrive to the station by walking, reduces (by 5.8%), which can be explained with the fact that a large share of pedestrian walk a path of more than 820 meters to the station, with a standard deviation of 400 m. From this we can conclude that a regulated and protected bike storage room would improve accessing the station with bikes, assuming that we neglect other factors (i.e. weather).

7. CONCLUSION

In this article we presented two models for the detection of spatial accessibility to railway stations, i.e. with analysis of influential areas (buffer analysis) and with access mode to the station and the station choice. The results of the research will be published in the next article, because rail users are still being interviewed in Maribor region. The findings of the research will be important for determining the effects of infrastructure measures of public passenger transport in railway transport and beyond.

We find that easier accessible stations are more likely to be selected for departure stations as those that are more difficult to access. The next observation is that when other factors do not change, departure stations will be chosen on the criteria of higher train frequency. Furthermore, the choice of departure station depends on the quality of the station. The quality of a station is defined as the quality of the rail and other complementary services at the station. Frequency, network connectivity and coverage are some examples of railway services. The presence of other complementary services, such as availability of parking places, protected and sheltered bicycle sheds and regulated waiting rooms increase the attractiveness of departure station.

Table 5

Selection of alternatives ways: results of hypothetical access modes

			Station				
Modal split		**Choice**	**Poljčane**	**Slovenska Bistrica**	**Pragersko**	**Total**	**% Frequency**
Walk	Actually		63	6	39	108	26.2%
	Hypothetical alternative	A	8	0	3	11	20.4%
		B	11	0	2	13	
		C	44	6	34	84	
	The Difference (%)		-30,2%	0.0%	-12.8%	84	-5.8%
Bike	Actually		8	5	9	22	5.3%
	Hypothetical alternative	A	0	3	0	3	17.0%
		B	0	0	0	0	
		C	8	2	9	19	
	The Difference (%)		0.0%	-60.0%	0.0%	19	11.7%
Car	Actually		92	80	76	248	60.2%
	Hypothetical alternative	A	24	23	1	48	39.3%
		B	10	10	18	38	
		C	58	47	57	162	
	The Difference (%)		-37.0%	-41.3%	-25.0%	162	-20.9%
Public transport (bus)	Actually		22	12	0	34	8.3%
	Hypothetical alternative	A	0	0	0	0	23.3%
		B	0	0	0	0	
		C	22	12	0	34	
	The Difference (%)		0.0%	0.0%	0.0%	34	15.0%
Total (actual)			185	103	124	412	100%

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