THE IMPACT OF PUBLIC TRANSPORT ON REGIONAL DEVELOPMENT IN THE TRNAVA SELF-GOVERNING REGION

Wpływ transportu publicznego na rozwój regionalny w regionie Trnawy

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Abstract: The accessibility of regional centers by public transport in a defined area is a very specific problem. Depending on the organization of public transport, there is a potentially related phenomenon – social transport exclusion. The aim of the study is to express the existence of a relationship between public transport and regional development in the rural self-governing region Trnava. At the same time, we identify municipalities – more precisely areas – with reduced transport accessibility in relation to their regional development and we determine the most advantageous means of public transport for the population who does not have the possibility to use a car. The procedure was to use an electronic database of train and bus timetables to obtain information about the studied characteristics for the return journey during the 24 hours of working days (Tuesday). We found that rail and combined transport have better quality in about half of the region's municipalities. The Pearson correlation coefficient of product of moments indicated that the value of the correlation between the number of points for public transport and points for regional development is only 0.36, and therefore there is no strong connection between them. However, the individual extreme and average values of these indicators and especially their sub-components have shown us that there is a certain dependence between these values. The results show that despite a lower impact on public transport on regional development, it has a more decisive influence, leading to the strengthening of public transport.

Key words: Trnva self-governing region, complex accessibility, regional development, rail, bus and combined transport

1. Introduction

Modern socio-economic processes increase pressure on the economic efficiency and the spatial organization of public transport. Residents of rural regions are aware that employment positions and services are saturating to regional centers. Disadvantageous geographical location and low population concentration transfer such areas of reduced public transport services, which results in direct negative effects on their inhabitants, in terms of access to the labor market, better education, services or the arrangement of important cultural and social events (Székely and Novotný, 2020).

Public transport is important primarily as a more environmentally friendly alternative to individual car transport, as a means of transport for citizens who do not have the opportunity to use a car (Horňák and Pšenka, 2010, 2013). Motor vehicle ownership is currently a matter of prestige and a reference to the owner's solvency and is in many cases a necessary way out of the spatial isolation of social exclusion (Horňák, et al., 2016).

The accessibility of Slovak cities in terms of correlation between settlement, configuration of transport network and territorial division was given more attention in the geographical society (Tolmáči, 2002; Michniak, 2003; Székely, 2004; Horňák, 2005) than the accessibility of rural municipalities to their natural centres (Trembošová et al., 2018; 2019 and 2020), as well as problems and challenges of railway transport in Slovakia (Michniak, 2018). In Czech geography, public transport and its spatial connections are discussed mainly in the regional cities (Kraft and Vančura, 2009; Marada et al., 2010; Chmelík et al., 2010; Seidenglanz, 2010, as in the regions (Boruta and Ivan, 2010).

From specialised Polish literature, we were inspired by the publication Taylor (2006), which highlighted the importance of public transport in the connection to cities and settlements in their background on the sample of canceled public rail connections in the transforming Poland. Traffic overload in Poland as well as in other developed countries is considered by Połom and Tarkowski (2018) and Połom et al. (2018) as well as Taylor and Ciechański (2018) as one of the most significant problems for the functionality of inhabitants of cities and regions. The statement of these authors is that this was not done only as a consequence of the increase in the wealth of the population, but also in relation to the chaotic suburbanization. Guzik et al. (2016) refer to the chaotic suburbanization and the associated deterioration in accessibility by public transport based on research in the functional region of Olsztyn as it is the works of Kurek et al. (2017) from Krakow, Goliszek et al. 2020 from Szczecin. We were influenced by the work of Ciechański (2019 and 2020a,

b) from the Polish-Slovak border. Grengs et al. was an inspiration for us as a non-European work (2010).

Several authors have discussed the impact of transport, primarily road infrastructure, on regional development (Hůrský, 1971; Bryan et al., 1997; Gielisse, 1998; Kanaroglou et al., 1998; Linneker and Spencer, 1996; Rajčáková, 2005; Wokoun et al., 2008).

The aim of the study is the recognition of the regional development in relation to the specificity of public transport in the rural self-governing region of Trnava. Another work goal is a qualitative analysis of public transport in the period 2017-2020 and the identification of municipalities with deteriorated transport accessibility in relation to regional development. At the same time, the aim is to determine the most advantageous mode of public transport for specific inhabitants of municipalities who do not have the possibility of transport by car. We demonstrated two established hypotheses:

H1: the status of public transport in municipalities is related to their regional development,

H2: railway transport is a significant part of the transport system in the Trnava self-governing region.

The inhabitants of these municipalities may be hypothetically exposed to the pressure of transport-related social exclusion due to the difficult conditions of transport accessibility of the regional centre with its wider zone (Székely and Novotný, 2020; Lucas 2012; 2019).

The importance of the study is on two levels, firstly for the need of the emerging integrated transport system (Chudík et al., 2018) and at the same time as part of the project base of regional development management.

2. Study area

After the reorganization of the administrative division of Slovakia in 1996, the Trnava self-governing region (TTSK) was created in the west part of Slovakia and consists of 7 districts: Dunajská Streda (DS), Galanta (GA), Hlohovec (HC), Piešťany (PN), Senica (SE), Skalica (SI) and Trnava (TT) (Fig. 1).

As the only region in Slovakia, it is bordered by up to 3 states. In the west it borders with the Bratislava self-governing region and Austria, in the north-west with the Czech Republic, in the north with the Trenčín self-governing region, in the east with the Nitra self-governing region and in the south with Hungary (Trembošová et al., 2020).

Based on the surface area, it belongs to smaller Slovak regions (occupying 10.3% of the country's territory) and with the current (in 2019) number of about 563 thousand inhabitants (10.3% population of the whole state) is also belongs to the more populated
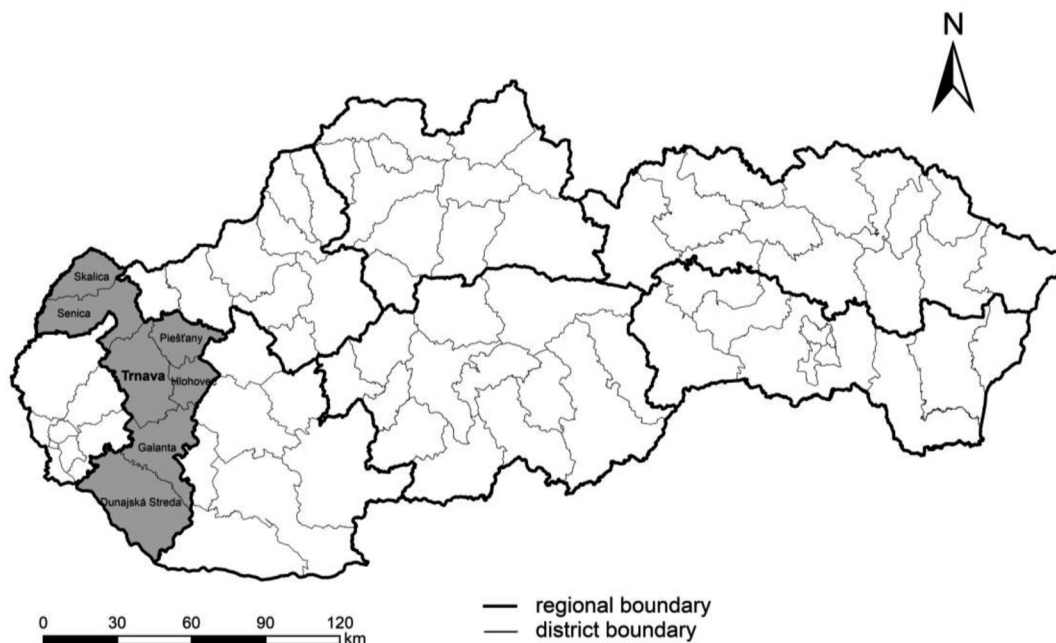
Fig. 1. The Trnava self-governing region: geographical location of study area

Source: own elaboration.

regions with above-average density region of Slovakia (134.9 inhabitants per km^2). The area of Trnava self-governing region (NUTS 3), consisting of 251 municipalities, was classified as a "predominantly rural region" in the governmental document "Rural Development Program in Slovakia for the 2014-2020 programming period", since its rural population living in rural areas represents more than 50% of the total regional population in the ratio of 52.8% rural: 47.2% urban (for 1.7.2019).

Due to its physical and geographical character, the area of the Trnava self-governing region has excellent potential for the existence and future use of railway and road infrastructure. The problem, in terms of the transportation network, is the large watercourses flowing through this area. In terms of settlement, the territory of the Trnava self-governing region consists of large compact municipalities. The region is a dynamic industrial center of Slovakia, focusing mainly on the industrial production of standardized production, which a less qualified workforce. The railway transport infrastructure with a length of 280 km has 62 tariff points (30 stations and 32 stops). The railway runs through 55 municipalities, which represents 21.9% of the total number of 251 Trnava self-governing region municipalities. The road transport infrastructure is 1951 km long and consists of 8 main roads: motorway D1, two-lane expressway R1, road I/61, road I/51, road I/2, road I/62, road I/75 and road I/63 (www.spravaciest.sk). The transport network has a convergent shape.

3. Data and methods

The priority of public transport in the region is to ensure the transport of the population to work, schools, medical or social facilities and commercial services. For this purpose, indicators were selected, which we divided into two data matrixes.

The data matrix of regional development expresses 251 (municipalities in the region) x 9 indicators of regional development, namely the gross migration saldo, the share of outgoing population outside the municipality to work and school, unemployment, share of economically active population, percentage of houses connected to tap water, number of retail chain food companies, existence of elementary schools, number of industrial companies with more than 10 employees, indebtedness of the municipality per 1 person. The public transportation data matrix expresses 251 (municipalities in the region) x 3 indicators of public transport possibilities (distance, time, number of transfer points) to 5 goals of attendance: Trnava as a regional city, the district town of the district and 3 other goals that commute from the given municipalities based on the results of Sčítania obyvateľov, domov a bytov 2011 – Census (hereinafter as SODB 2011). Each indicator of regional development and connection by public transport could obtain 0 to 10 points.

The data of the regional devel014pment matrix were acquired from SOBD data in 2011 (www.statistics.sk) and the data of the transport network matrix were collected in the period from autumn 2017 to January

2020, using the method of an individual human (not robotic) research. They were collected for 3 modes of transport: train, bus and combined (a mode of travel by at least one train and one bus, excluding the public transport). Train connections were searched directly in the timetable published on www.slovakrail.sk website (in the autumn of 2019 it was transferred to www.zssk.sk website). Bus and combined connections were ascertained using a search engine on cp.sk. Connections were searched on multiple dates. Tuesday was chosen as research day, since it was not the day before or after the weekend, nor the last day of school, except for school holidays.

Transport journeys at four key times were selected: i) journeys leaving at 04:00 from municipalities with the earliest arrival in in centrum of commuting (important for tourists, long-distance travelers and commuters to work for morning shift); ii) journeys with the latest departure from municipalities arriving at 07:30 in centrum of commuting (important for commuters to school, work, doctor office etc.); iii) journeys with the earliest arrival in municipalities leaving from in centrum of commuting at 14:00 (important for commuters from school, work, doctor office etc.); iv) journeys with the latest departure from in centrum of commuting arriving in municipalities by 24:00 (important for tourists, long-distance travelers, commuters from afternoon shift). In the case of time equality during the calculation, the number of transfers and a traveled distance was taken into account (lower is better).

Six pieces of information were identified on detected connections simultaneously. A detailed description is stated by Kohutiar (2020).

The proposed calculation procedure was named complex accessibility (kd) calculation and was applied in Trembošová et al. 2018, Trembošová et al. 2019 and Trembošová et al. 2020.

$$kd = \frac{s}{t \, x \, p} \qquad (1)$$

kd – complex accessibility
s – distance traveled
t – time traveled
p – number of transfers

For the purpose of complex accessibility calculation in this paper a standard Tuesday (February 6, 2018) was considered, thus eliminating the increasing trend of traffic before and after the holidays, but also the decreasing trend of traffic during them.

Data used for railway journeys calculations were acquired only for municipalities with at least one tariff point – a railway station or a stop from the scheduled timetable. The difference between a railway/bus station and stop has not been considered for the calculation purposes.

Data used for bus and combined transport services were with attention to the number of lines, routes, and bus operating companies acquired through a search engine at. The default filter setting of the search engine was used to generate search results, the only exception was filtering out inner city transport buses. Combined transport combines the usage of both bus and train transport during journeys.

The public transport matrix expresses the total of the 9 highest values of accessibility in each municipality.

Testing was carried out by using a square contigency test of qualitative signs, where testing was performed by χ2 test at a significance level p with value 0.05. If value of calculated χ2 is lower than the critical value, the two signs are indenpedent – the dependence does not exist. Otherwise, if the value of calculated χ2 is higher than the critical value – the dependence exists. The relationship intensity between characteristics of the respondents and types of shopping behaviour were set on the basis of contigency C coefficient. Testing was processed in SPSS software. The Pearson contingency coefficient expresses in the contingency table, the degree of dependence between two qualitative features and is determined by the relation:

$$C = \sqrt{\frac{x^2}{x^2 + n}}$$

where χ2 is the Pearson test statistic (square contigency test)

$$n = \sum_{i=1}^{r} \sum_{j=1}^{s} n_{ij}$$

The more C takes values close to 1, the higher is the dependency of both qualitative features. Conversely, C valuse close to 0 indicate very low almost none dependence.

4. Surveys

If we take into account the results of complex accessibility, we cannot confirm the thesis that rail transport has at least a partial (in the case of combined transport) share in more than half of the connections with the highest values of complex accessibility for individual municipalities within the Trnava region. However, we can confirm its important role in ensuring quality connections in the region, since these connections make up approximately 30-50% of the set of connections.

In the work of Trembošová a kol. (2018), in the section of analysis and comparison of all 4 numerical indicators of transport, we pointed out that rail and combined transport is of high-quality in about half of the municipalities in the region with such a methodology (Fig. 2).

Although the Pearson correlation coefficient of the product of moments indicated that for the whole Trnava region the value of the correlation is between the number of points for transport and points for regional development is only 0.36, and therefore there is no strong dependence between them (from 0.5 upwards), individual extreme and average values of these indicators and especially their sub-components have demonstrated that there is a certain dependence between these values and that these components are affected at least indirectly.

When calculating this coefficient for individual districts, we found that the strongest dependence is in the district of Piešťany (0.55) and the weakest in the district of Senica (0.26).
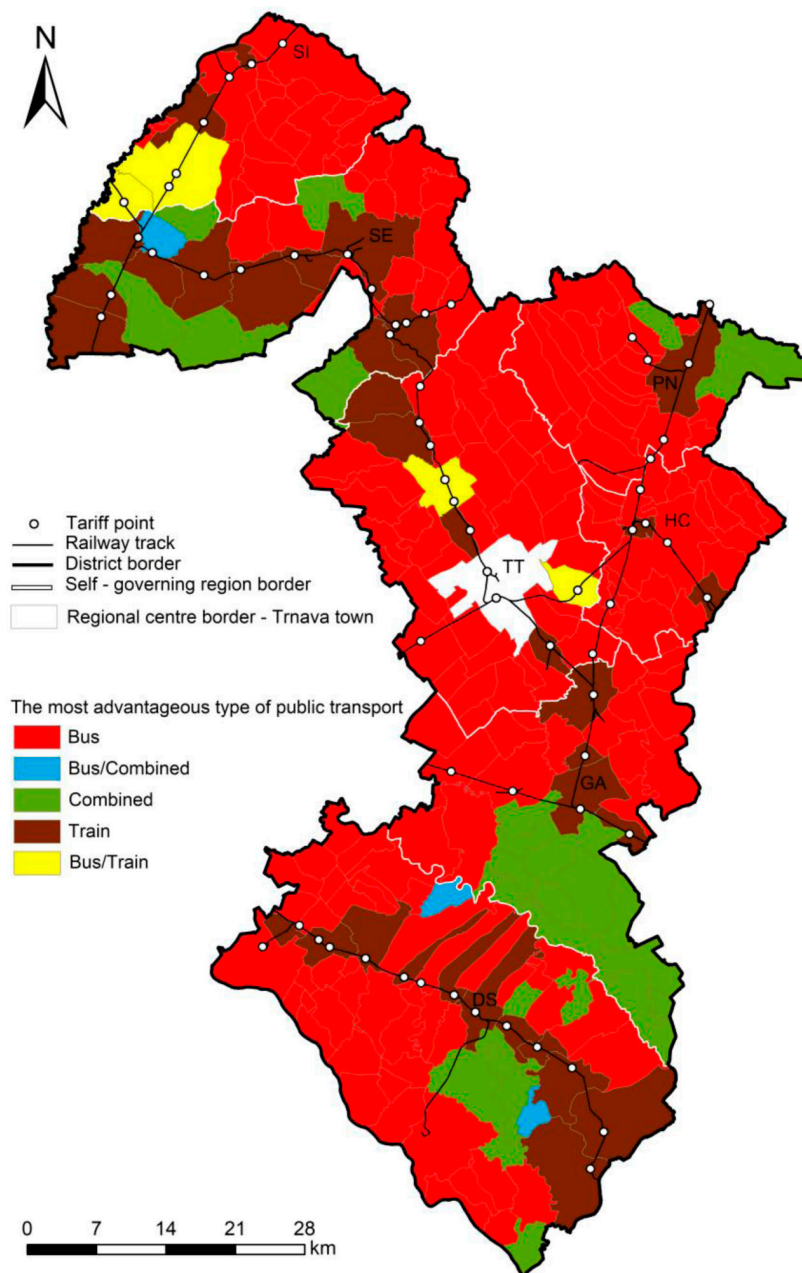

Fig. 2. Benefit of individual types of transport for the municipalities of the Trnava self-governing region (accessibility for the years 2017-2020)

Source: own elaboration

Tab. 1. The Pearson correlation coefficient of public transport and regional development at the level of districts in Trnava self-governing region.

District	Public transport	Regional development	The Pearson coeficient of correlation
Dunajská Streda	31.68656	43.80597	0.29027
Galanta	33.41	49	0.33581
Hlohovec	26.75	44.7083	0.54661
Piešťany	28.29629	44.5	0.55502
Senica	37.51612	42.75	0.26078
Skalica	28.85714	42.57142	0.52065
Trnava	34.37778	47.68889	0.36991

Source: own elaboration

In the Piešťany district, this may be due to its transport and development diversity, as a result of which there is a greater need to improve transport in the municipality so that other components of regional development can be also improved. On the other hand, in the district of Senica, regional development is usually a product of other factors that are very difficult to change of quality transport, such as terrain, lost settlement, tourism, population and others.
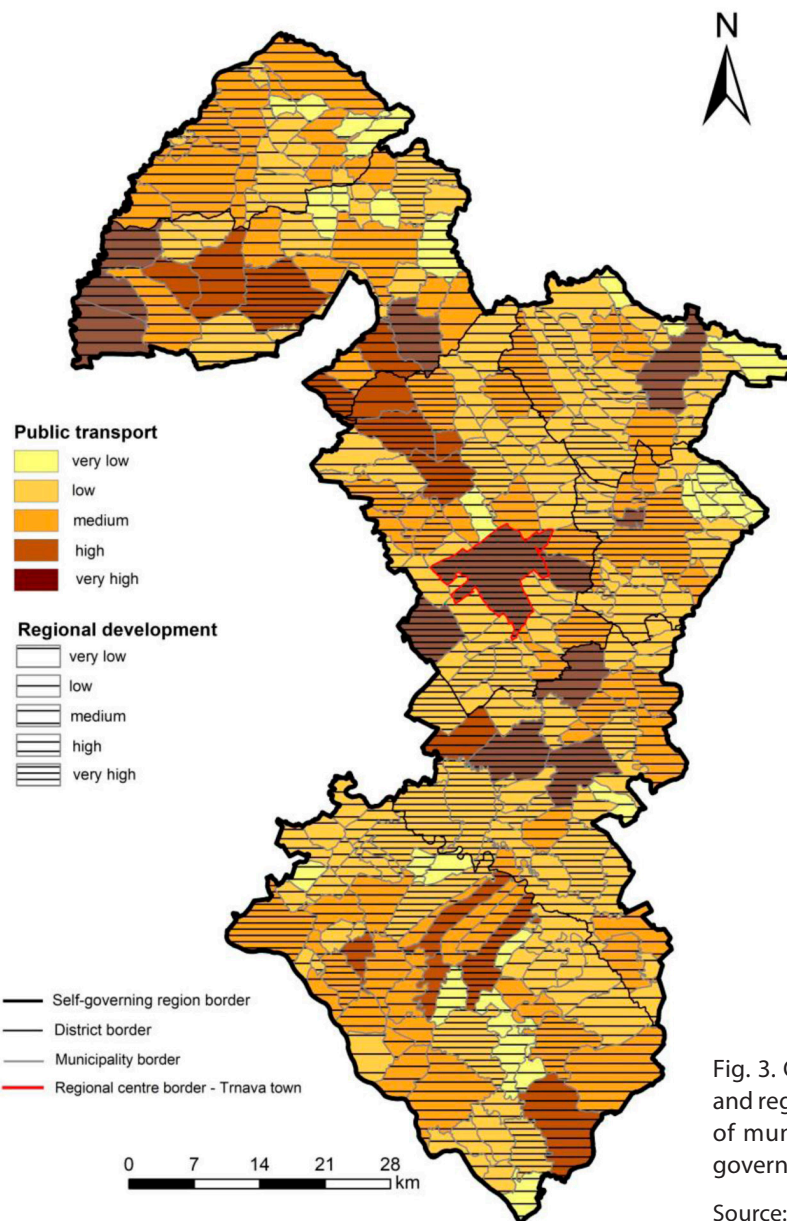

Fig. 3. Correlation of public transport and regional development at the level of municipalities of the Trnava self-governing region

Source: own elaboration

Compared to other regions of Slovakia and the Czech Republic, the Trnava region has a specific ring shape around the Bratislava region, which forms a suburban zone, but unlike the Středočeský (Central Bohemia) region it has its own regional city and does not completely surround the metropolitan region, as Bratislava is the only capital in Europe which borders two states and therefore the remaining neighbors of the Bratislava region are already in neighboring countries. In addition, as the only Slovak region, Trnava region borders three countries, although its border with the Republic of Austria is negligible and it is more practical for 5 of the 7 TTSK districts to travel to Austria via Bratislava. Another specific feature of the region is its low unemployment. Consequently, for most regions, the primary goal of attendance is not Trnava, but Bratislava. As proof we present attendance at work and schools from individual TTSK districts to Bratislava (BA), attendance to Trnava (TT), attendance within the region, attendance to the district town and attendance within the district (Tab. 2).

line). In addition, the semi-private (a subsidiary of the German state railways) Arriva on the Prague – Nemšová – Trenčín – Leopoldov – Nitra route (currently no longer running to Slovakia) and the private Regiojet carrier on the Bratislava – Žilina – Košice (currently this route is divided between the lines Prague – Bratislava – Žilina and Prague – Ostrava – Žilina – Košice), Bratislava – Kúty – Prague and Prague – Kúty – Bratislava – Žilina. According to the law, contract bus transport must already compete. Even in last year's tender, the current carriers succeeded in the Trnava region, namely SAD Dunajská Streda (private carrier), Arriva Trnava (semi-private carrier) and SKAND Skalica (private carrier). In addition, lines of other carriers, such as the private VYDOS bus (Hodonín – Holíč – Skalica –Veselí nad Moravou), SAD Trenčín (private, Piešťany district) and Arriva Nitra (semi-private, eastern edge of the region), also visit the peripheral areas of the region. Commitment rail transport is also to compete, but so far the only competing line was Bratislava – Komárno, with no carrier signing up for this competition for

Tab. 2. Passenger flows in the analyzed area.

District	Coming to BA	Coming within the region outside TT and district	Coming to TT	Coming within the district outside the district town	Coming to the district town
Dunajská Streda	10367	472	55	7551	8081
Galanta	7079	1768	2314	5826	4741
Hlohovec	1581	2077	2480	1566	2664
Piešťany	1757	1648	1638	2711	4705
Senica	3332	1994	654	2353	3229
Skalica	1370	1288	212	2126	4208
Trnava	6229	1966	13401	5986	13401

Source: own elaboration based on data obtained from census 2011, Statistical Office of the Slovak Republic

Public transport in Slovakia is divided into mandatory and commercial. Commercial includes all long-distance bus lines, IC trains, some tourist train connections and long-distance connections of private railway carriers. Most train and regional and city bus connections are mandatory. Commitment railway transport is ordered by the state, but if the state does not order a sufficient number of connections for a certain line, the self-governing region can order the remaining connections (in the past the Zohor – Záhorská Ves line, currently strengthened Leopoldov – Hlohovec train connections). Commitment regional bus transport is ordered by the self-governing region. Public transport is usually ordered by the city, but we did not address it in the article. At the time of drawing data for the article (2017-2020), there were 2 carriers operating in compulsory railway transport – the state ZSSK (most lines) and the private Regiojet (Bratislava – Komárno line; currently it also operates transport on this ZSSK

the last time, so in agreement with the Ministry of Transport, ZSSK took over the transport on this route from Regiojet.

5. Conclusions

Regional development and public transport at a regional level is a tool for improving the quality of life. Efficiency improvement of public transport and the cancellation of local connections, especially on the suburbia, often brings negative aspects and reduces the quality of life of the rural population by increasing the cost for transport but also by time loss and various forms of discomfort. The situation of people from rural areas living at greater distances from cities is further deteriorating throughout Slovakia (Székely and Novotný, 2020). These people may also be exposed to the problem of transport-related social exclusion. On the periphery of the regions, this phenomenon

occurs in all areas of life and is a natural occurrence of segmentation of settlements in terms of the theory of centrality and hierarchy. Nevertheless, we increasingly encounter the term internal periphery. It was also reflected in the results of our study based on the analysis of regional development and public transport at the level of municipalities in the district of Galanta, Hlohovec and, surprisingly, also in the close area of the regional city of Trnava in the municipality.

Taking everything into account, the strong relationship between the public transport domain and regional development was not confirmed. It is worth mentioning the personal opinion of the expert M. Horňák (from a private interview) that regional development causes the strengthening of transport more than vice versa. We agree with this view of the issue. However, the problem is that as a result of such a procedure, both public and individual transport in settlements, in which the level of regional development has significantly preceded the addition of quality transport connections, often collapses (e.g. Hlohovec, west of Galanta district, etc.).

The correlation expressed by the Pearson correlation coefficient also did not completely confirm the core function of railway transport in the Trnava region. We highlight its important role, emphasized by its continuity at the borders of districts and regions as well. We assume that the impact of the planned extension of the integrated transport system of the Bratislava Region to the area of the entire Trnava Region will create a continuity of bus lines at railway tariff points with connections to trains.

Nowadays, the orientation of the population of the Trnava region to the nearby capital of the Slovak Republic – Bratislava – is mentioned frequently. Thanks to this proximity, the municipalities of the Trnava region with "favorable" connections to Bratislava are becoming attractive destinations for suburbanization for families who cannot economically afford to live directly in Bratislava or its primary satellites. This group includes the municipalities of the Dunajská Streda district (western part) and the close area to the main road and railway line, the Galanta district, the southwest of the Senica district (surroundings of Kúty) and the southwestern part of the Trnava district. In consequence, these municipalities are characterized by a higher gross migration balance. On the other hand, municipalities with a small population and very poor transport accessibility have a problem keeping young people, as there is only a very weak facility and residents have to commute for almost all public and commercial services. Such villages are on the external periphery of the region – northwest, northeast and southeast. The result points to significant disparities and natural segmentation of the region in terms of

quality of life. We agree with the statement of Székely and Novotný (2020) that unfavorable geographical location and low concentration of inhabitants predispose peripheral areas to reduced public transport services, which results in direct negative effects on the quality of life of their inhabitants. And this is a challenge for the Trnava self-governing region institutions and regional development planning.

Acknowledgements

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