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**Analysis of public transport connections along the railway line No. 406 on the section
Szczecin Główny – Police**

Abstract: The article presents an analysis of selected public transport lines running along the railway line Szczecin Główny – Police. Examined journey time by public transport between the railway stations and stops. Compared to the travel time by train and passenger public transport vehicles. In addition, a comparison of planned and actual travel times of public transport vehicles. In a general manner specified number of passenger public transport.

Keywords: Rail; Public transport; Travel time

Introduction

Railway line No. 406 Szczecin Główny - Trzebież Szczeciński runs through several districts of Szczecin, where there is a significant number of stations and stops. From October 1, 2002, regular passenger train traffic was completely suspended. Currently, the line is closed for traffic on the section Police - Trzebież. On the Szczecin Turzyn - Police section there is a movement of freight trains. Regular passenger connections on the Szczecin - Police route are city buses. The course of the railway line allows it to be used to improve public transport on the Szczecin - Police route.

History and significance of railway line No. 406 on the section Szczecin Główny - Police

The section of the railway line from Szczecin to Police was built at the end of the 19th century. It performed two functions [1]:

- urban beltway (in the section Szczecin Główny - Szczecin Drzetowo),
- suburban railway (on the remaining section).

In the nineties of the twentieth century, there was an intensive development of motorization and a decrease in rail passenger transport. Large industrial plants have fallen, in particular, the smelter and paper mill located near the railway line to Trzebież. Railway infrastructure was gradually degraded. After 2000, there was a reduction in the number of passenger connections, and in 2002, their total liquidation. Currently, freight trains run on the Szczecin Turzyn - Police section. Over the last dozen or so years, the line has not been modernized. Only ongoing repairs were carried out. Most train stops are in poor condition. Passenger passenger trains were poorly integrated with the public transport system. The train ride required the purchase of a separate ticket. Public transport tickets were invalid. The poor condition of the infrastructure caused a reduction in the speed of trains. Public transport was becoming more and more competitive in relation to too slow trains and devastated passenger stops. On the route Szczecin Główny - Police, a direct connection by public transport occurs

only at night. In addition, between some districts of Szczecin, passenger rail transport can improve public transport connections.

Methodology and analysis of research

The research was conducted in October and November 2016 on business days in the afternoon transport peak. They consisted in examining the travel time, determining the number of passengers of means of public transport in the conditions of actual exploitation. Public transport connections are served by one tram and several bus carriers as part of a common tariff. The research covered connections between all stations and passenger stops along railway line No. 406 on the section Szczecin Główny - Police and connections with selected stations and the Main Railway Station in Szczecin. Table 1 presents the analyzed corridors of public transport. The analyzed corridors of public transport on selected sections are presented in tab. 2. When choosing the stations of Szczecin Turzyn, Szczecin Niebuszewo and Police, the number of inhabitants [3, 7] and the possibility of building transfer centers were taken into account. The planned travel time was compared with the actual travel time of public transport means. In addition, a comparison of the planned time of travel by a passenger train from 2001 with the current planned time of public transport is presented. The planned time of traveling by train was determined on the basis of the timetable from 2001 [2], and the planned time of traveling by public transport on the basis of the current timetable [8]. Currently, the operational parameters of the analyzed section of the railway line are worse compared to the state from 2001. According to "Annex 2.1 (A) List of maximum speeds - rail buses and EZT Regulations of train paths allocation (...) 2016/2017" [5] the maximum road speed currently fluctuates within 30÷80 km / h with additional speed limits up to 20 km / h included in the List of Permanent Alerts at the Szczecin Railway Lines Company, valid from December 11, 2016. "Based on the timetable from 2001, the maximum road speed of the 406 railway line on the Szczecin Główny - Police section was 50 km / h. Reconstruction of operational parameters to the state of 2001 will allow you to get the following travel times. The planned time of traveling by train, taking into account the time of access from the center of the housing estate to the station or the railway stop between all stations and stops of the railway line connecting Szczecin Główny and Police on some sections is shorter than the planned time of public transport. The largest difference occurs on the section Szczecin Gocław - Szczecin Glinki, where the planned time of traveling by train, taking into account the time of arrival is 9 minutes, and by means of public transport, 23 minutes. The smallest difference occurs on the section Szczecin Niebuszewo - Szczecin Drzetowo, where the planned time of the train taking into account the arrival time is 9 minutes, public transport 10 minutes and Szczecin Drzetowo - Szczecin Żelechowo, where the planned time of the train is 12 minutes, and public transport 13 min. On the Szczecin Główny - Szczecin Pomorzany section, the planned time of traveling by train, taking into account the time of arrival and the planned time of traveling by means of public transport is the same and amounts to 13 minutes. The planned time of traveling by train, taking into account the time of access from the center of the housing estate to the station or the railway stop between all stations and stops of the railway line connecting Szczecin Główny and Police on some sections is longer than the planned time of public transport. The largest difference occurs on the section Szczecin Gliniki - Szczecin Skolwin, where the planned time of traveling by train, taking into account the time of arrival is 13 minutes, and by public means 6 minutes. The smallest difference occurs on the section Szczecin Pomorzany - Szczecin Turzyn, where the planned time of travel by train takes 11 minutes, and public transport 10 minutes and on the section Szczecin Turzyn - Szczecin Pogodno, where the planned time of the train is 8 minutes, and the means public transport 7 min. A comparison of the planned travel time by a passenger train, taking into account the time of arrival and public transport, including the number of transfers, is presented in tab. 3. Fig. 1 shows a graphical

comparison of the planned time of a passenger train, taking into account the time of arrival and public transport, taking into account the number of transfers. The planned travel time is not significantly different from the real time of traveling by public transport. The biggest difference is in the section Szczecin Drzetowo - Szczecin Żelechowo, where the planned travel time is 13 minutes, and the actual travel time is 18 minutes. On the sections Szczecin Pomorzany - Szczecin Turzyn, Szczecin Gołęcino - Szczecin Goćław, Szczecin Glinki - Szczecin Skolwin, Szczecin Skolwin - Szczecin Mścięcino, Szczecin Mścięcino - Police planned and the actual travel time are the same. A comparison of the planned and real time of travel of means of public transport including the number of transfers is presented in tab. 4. Fig. 2 presents a graphic comparison of the planned and real time of travel of means of public transport, taking into account the number of transfers.

Tab. 1. Analyzed public transport corridors

No .	The type and number of the line	Section of the route (names of the stops)
1	Bus line No. 61	Owocowa Dworzec Dąbrowskiego
2	Tram line No. 11 Tram line No. 7	Dąbrowskiego Plac Kościuszki Plac Kościuszki Turzyn
3	Tram line No. 7	Turzyn Karłowicza
4	Tram line No. 7 Bus line No. 67	Karłowicza Poniatowskiego Poniatowskiego Traugutta
5	Bus line No. 67 Tram line No. 12	Traugutta Kołątaja Kołątaja Dworzec Niebuszewo
6	Tram line No. 12 Bus line No. 69	Dworzec Niebuszewo Niemcewiczka Niemcewiczka Rugiańska
7	Bus line No. 69 Bus line No. 58	Rugiańska Pasterska Komuny Paryskiej Żelazna
8	Bus line No. 59	Żelazna Paproczi
9	Bus line No. 59 Tram line No. 6	Paproczi Zajezdnia Gołęcín Zajezdnia Gołęcín Lipowa
10	Tram line No. 6 Bus line No. 102	Lipowa Goćław Goćław Zamknięta
11	Bus line No.102	Zamknięta

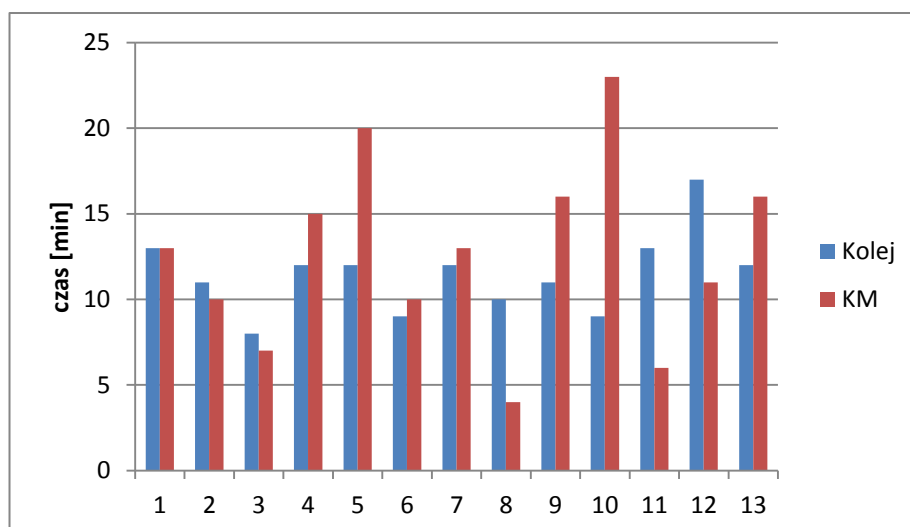
		Skolwin Dworzec
12	Bus line No. 102	Skolwin Dworzec
	Bus line No.107	Police Mścięcino Krzyżówka Police Mścięcino Krzyżówka Police Palmowa
13	Bus line No.107	Police Palmowa
	Bus line No.102	Police Mścięcino Krzyżówka Police Mścięcino Krzyżówka Police Dworzec

Tab. 2. Analyzed public transport corridors on selected sections

No.	The type and number of the line	Section of the route (names of the stops)
1	Tram line No. 9	Plac Zawiszy Turzyn
2	Tram line No. 3 Tram line No. 12	Dworzec Główny Kołatąja Kołatąja Dworzec Niebuszewo
3	Tram line No. 6 Bus line No. 102	Dworzec Główny Goćław Goćław Police Dworzec

Tab. 3. A comparison of the planned time of travel by passenger train, taking into account the time of arrival and public transport, including the number of transfers

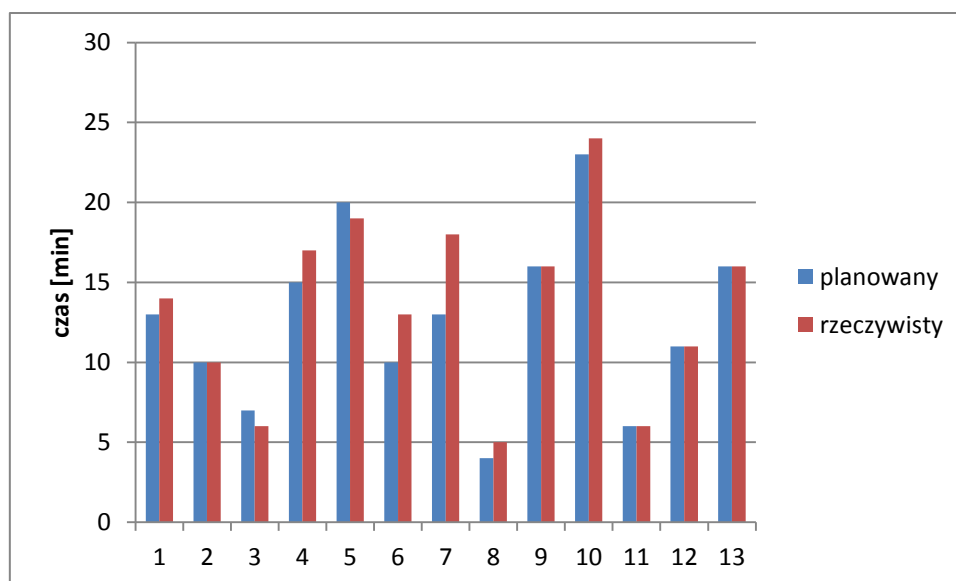
No.	Route section	Planned travel time by train	Time to get from the center of the estate to the railway station (stop)	Real travel time by public transport	Number of transfers on the public transport route
1	Szczecin Główny – Szczecin Pomorzany	3 min	10 min	13 min	0
2	Szczecin Pomorzany – Szczecin Turzyn	3 min	8 min	10 min	1
3	Szczecin Turzyn – Szczecin Pogodno	3 min	5 min	7 min	0
4	Szczecin Pogodno – Szczecin Łękno	2 min	10 min	15 min	1
5	Szczecin Łękno – Szczecin Niebuszewo	4 min	8 min	20 min	1
6	Szczecin Niebuszewo – Szczecin Drzetowo	3 min	6 min	10 min	1
7	Szczecin Drzetowo – Szczecin Żelechowo	3 min	9 min	13 min	1
8	Szczecin Żelechowo – Szczecin Gołęcino	2 min	8 min	4 min	0
9	Szczecin Gołęcino – Szczecin Goćław	3 min	8 min	16 min	1
10	Szczecin Goćław – Szczecin Glinki	4 min	5 min	23 min	1
11	Szczecin Glinki – Szczecin Skolwin	4 min	9 min	6 min	0
12	Szczecin Skolwin – Szczecin Mścięcino	5 min	12 min	11 min	1
13	Szczecin Mścięcino – Police	4 min	8 min	16 min	1



1. Graphical comparison of the planned time of travel by passenger train, taking into account the time of arrival and public transport, including the number of transfers

Tab. 4. A comparison of the planned and real time of travel of means of public transport including the number of transfers

No.	Route section	The planned journey time by public transport	Real travel time by public transport	Number of transfers on the public transport route
1	Szczecin Główny – Szczecin Pomorzany	13 min	14 min	0
2	Szczecin Pomorzany – Szczecin Turzyn	10 min	10 min	1
3	Szczecin Turzyn – Szczecin Pogodno	7 min	6 min	0
4	Szczecin Pogodno – Szczecin Łękno	15 min	17 min	1
5	Szczecin Łękno – Szczecin Niebuszewo	20 min	19 min	1
6	Szczecin Niebuszewo – Szczecin Drzetowo	10 min	13 min	1
7	Szczecin Drzetowo – Szczecin Żelechowo	13 min	18 min	1
8	Szczecin Żelechowo – Szczecin Gołęcino	4 min	5 min	0
9	Szczecin Gołęcino – Szczecin Gocław	16 min	16 min	1
10	Szczecin Gocław – Szczecin Glinki	23 min	24 min	1
11	Szczecin Glinki – Szczecin Skolwin	6 min	6 min	0
12	Szczecin Skolwin – Szczecin Mścięcino	11 min	11 min	1
13	Szczecin Mścięcino – Police	16 min	16 min	1



2. Graphical comparison of planned and actual time of public transport, including the number of transfers

In the examination of connections with selected stations and the Main Railway Station in Szczecin on sections Szczecin Główny - Szczecin Turzyn, Szczecin Główny - Szczecin Niebuszewo, the planned time of the train taking into account the arrival time is longer than the planned time of public transport, while on the Szczecin Główny - Police section, the planned time the passage by train, taking into account the time of arrival is shorter than the planned time of traveling by public transport. The largest difference occurs on the section Szczecin Główny - Police, where the planned time of the train, taking into account the arrival time is 51 minutes, and the planned time of traveling by public transport 71 minutes. The smallest difference occurs on the section Szczecin Główny - Szczecin Niebuszewo, where the planned time of the train, including the time of arrival is 23 minutes, and the planned time of traveling by public transport is 20 minutes. A comparison of the planned time of a passenger train, taking into account the time of arrival and public transport, including the number of transfers on selected sections, is presented in Tab. 5. Fig. 3 shows a graphical comparison of the planned time of a passenger train, taking into account the time of arrival and public transport, taking into account the number of transfers on selected sections.

The planned travel time and the real time of travel by public transport on the sections Szczecin Główny - Szczecin Turzyn, Szczecin Główny - Szczecin Niebuszewo, Szczecin Główny - Police is not significantly different. The largest difference occurs on the Szczecin Główny - Szczecin Niebuszewo section, where the planned travel time, is 20 minutes, and the actual travel time is 23 minutes. The smallest difference is on the section Szczecin Główny - Szczecin Turzyn, where the planned travel time is 9 minutes, and the actual travel time is 8 minutes. A comparison of the planned and real-time of travel of means of public transport including the number of transfers on selected sections are presented in Tab. 6. Fig. 4 shows a graphic comparison of the planned and real time of travel of means of public transport, taking into account the number of transfers on selected sections. Three numerical compartments were used to determine the number of passengers using public transport:

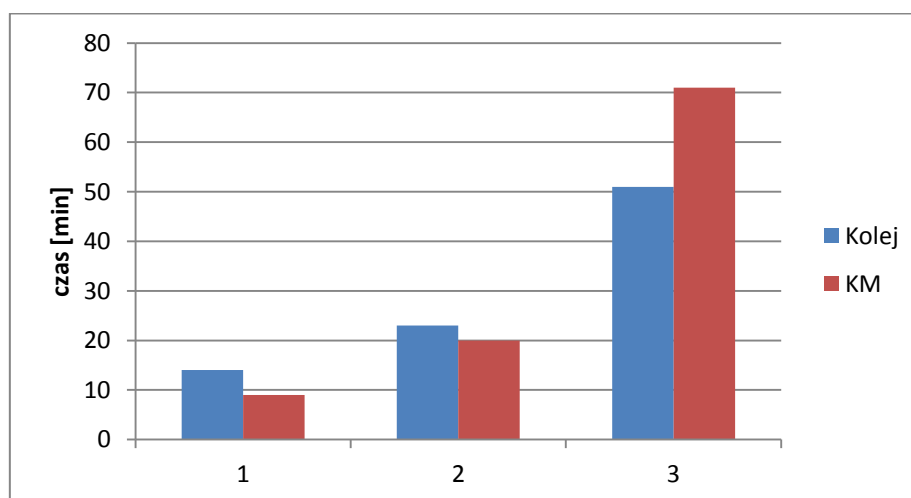
- less than 50 people,
- from 50 to 100 people,
- over 100 people.

In the study on public transport connections of all stations and stops along the railway line, the number of passengers is usually between 50 and 100 people. The least frequent

number of passengers is over 100 people. Research on public transport connections on sections Szczecin Główny - Szczecin Turzyn, Szczecin Główny - Szczecin Niebuszewo, Szczecin Główny - Police showed that most often the number of passengers is from 50 to 100 people. The number of passengers above 100 people has not been demonstrated. The research on the actual time of travel of means of public transport and the number of passengers due to the number of measurements taken is for illustrative purposes only.

Tab. 5. Comparison of the planned time of a passenger train taking into account the time of arrival and public transport on selected sections, including the number of transfers

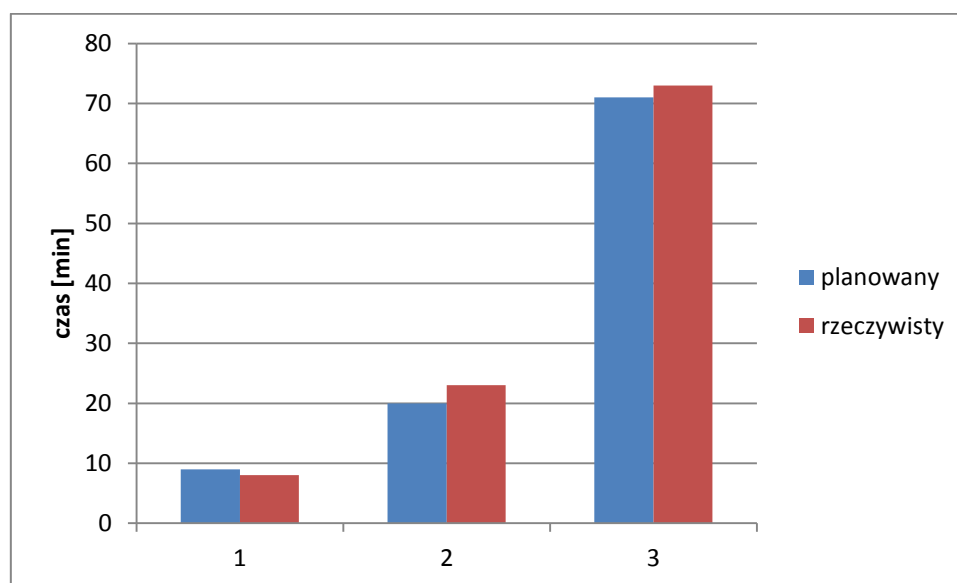
No.	Route section	The planned travel time train	Time to get from the center of the estate to the railway station (stop)	The planned journey time by public transport	Number of transfers on the public transport route
1	Szczecin Główny – Szczecin Turzyn	6 min	8 min	9 min	0
2	Szczecin Główny – Szczecin Niebuszewo	15 min	8 min	20 min	1
3	Szczecin Główny – Police	43 min	8 min	71 min	1



3. Graphical comparison of the planned time of travel by a passenger train, taking into account the time of arrival and public transport, including the number of transfers on selected sections

Tab. 6. A comparison of the planned and real time of travel of means of public transport, taking into account the number of transfers on selected sections

No.	Route section	The planned journey time by public transport	Real travel time by public transport	Number of transfers on the public transport route
1	Szczecin Główny – Szczecin Turzyn	9 min	8 min	0
2	Szczecin Główny – Szczecin Niebuszewo	20 min	23 min	1
3	Szczecin Główny – Police	71 min	73 min	1

**4.** Graphical comparison of planned and real-time of travel of means of public transport, taking into account the number of transfers on selected sections

Conclusions

On the basis of the conducted research, it was found that the planned time of a passenger train taking into account the time of access from the center of the housing estate to the station or a railway stop in some sections is shorter compared to the planned time of public transport between all stations and stops along the railway line connecting Szczecin Główny with the Police as well as on selected episodes. This confirms that the railway connection has potential in the section under consideration, but a number of accompanying measures are required for the success of the undertaking. In order to run passenger trains, it is necessary to repair the railway infrastructure in the area of tracks, station platforms and stops. There is a need for tariff integration with public transport and a referral to handle the connection of modern rolling stock. Taking into account the limited availability of rail transport in the city, the construction of transfer centers near the Szczecin Turzyn and Szczecin Niebuszewo stations should be considered. This is made possible by the local zoning plan [4]. In the case of the railway station in Police, the construction of a transfer center should be considered, eliminating part of the station tracks. The number of passengers in means of public transport is large and it would be beneficial to include passenger train traffic in the network of public transport connections. The planned and actual travel time of means of public transport does not differ significantly. In 2001, on the route from Szczecin to Police, in the morning and

afternoon transport rides, passenger trains ran every hour [2]. Taking into account the estimated infrastructural limitations of railway line No. 406 on the section Szczecin Główny - Police as well as economics, passenger trains could run every 20 minutes during the transport peak period, and outside every 30 minutes. The use of the existing railway infrastructure on the route Szczecin Główny - Police in order to run trains is in the long run a beneficial solution, because it can improve the functioning of public transport, relieve traffic and reduce environmental pollution. The use of the existing railway infrastructure to launch passenger trains from Szczecin Główny to Police also provides for the project of the Szczecin Metropolitan Railway [6]. The Szczecin Metropolitan Railway is supposed to be, among others, a supplement to the public transport network in the area of the city of Szczecin. The introduction of one metropolitan ticket in the project coincides with the proposed tariff integration with public transport.

Source materials

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