ANALYSIS OF REALIZATION OF PUBLIC TRANSPORT BETWEEN KATOWICE CITY AND BOBRUNNIKI RURAL COMMUNE IN THE SILESIAN AGGLOMERATION USING BUSES OF THE KZK GOP COMPANY

The organization of public transport is an important element of a sustainable transport policy in the region. This is particularly relevant and important to the organization of transport in areas with a high degree of urbanization, for example Silesian Agglomeration. The article presents an analysis of connections organized by KZK GOP on the route allowing access from Katowice to one of the smaller town areas (Bobruniki rural commune) located in the Silesian Agglomeration.

INTRODUCTION

The Silesian Province is one of the most densely populated areas of Poland. A characteristic feature of the region is the large number of cities and small towns located a short distance from each other. This is due to a number of factors, of which the most notable is the most recent - post-war history of the region, which is associated with the fossil industry and metallurgy. Expansion of the region, especially during the 70 years of the twentieth century resulted in a significant influx of population during this period. In this period there was also a very strong expansion of the infrastructure - especially roads and railways in the region. The main reason was the possibility of a smooth implementation of the transport of excavated deposits and manufactured goods to neighboring countries (mainly in the direction of Soviet Socialist Republics). Established infrastructure is a very good part of the transport system, which can be and is also used for the organization of public transport in the area. This is very important because a large part of the population does not live in major urban centers, but in the neighboring towns and to ensure efficient and effective public transport should be a competition for individual transport in the area. In Poland, as in other so-called "Young democracies" improve of the economic conditions enabled the purchase and owning a car for a large part of the population. This contributes, however, to increase the number of vehicles on the road and often has the effect of transport congestion [1]. The solution to this problem is of course public transport. The use of public transportation to carry out daily trips is also in line with European Commission guidelines contained in the so-called: Green Book - guideline of the European Commission in shaping urban transport systems [23].

Public transport - to fulfill its task - must have the following parameters (for the user or passenger):

- Efficient (a large number of links for quick access to the destination).
- These factors in addition to providing appropriate state (both quantitative and qualitative), linear and point infrastructure also require an appropriate manner superstructure. One of the main factors that affect it is to develop and implement in a given area of an effective system of timetables. Develop timetables in order to meet the expectations of the organizer of public transport (mostly cities, municipalities), the carrier and, above all, the passenger is not an easy task [2, 3, 4, 5, 6, 7, 8, 9, 10, 22]. Very often it requires the use of different analytical approaches, simplified methods [10] and simulation or computer support [2, 3, 6] in order to facilitate the development of an optimal timetable. Despite taking these measures an important element of optimizing timetables is their subsequent analysis (analysis of actual timetables) and their possible modification in the event of having to adjust schedules to the needs of travelers.

Public transport in the agglomeration of collective Upper-Silesian (in its central part) is realized by several operators in different modes of transport. Predominant group are carriers providing services of buses, but in addition to bus, services are also carried out with the use of rail transport (railway and tram) and trolleybuses.

1. PUBLIC BUS TRANSPORT IN SILESIAN PROVINCE

Bus transport in the Silesian province is realized by several entities with different legal status (company, association of municipalities, etc.). The largest and the most important for public transport in the region are:

- KZK GOP,
- MZK Tychy,
- PKM Jaworzno,
- MZKP in Tarnowskie Góry.

The above-mentioned entities are not individual companies, but each of them is a collection of entities performing under one "umbrella" transport services in a separate area.

The entity implementing the majority of transport within the Katowice conurbation is a KZK GOP company, which according to the data provided by them supports an area of 1.7 thousand km², which is inhabited by almost 2 million people [24]. Area of KZK GOP activity is shown in Figure 1.
A large number of entities performing transport in the agglomeration causes that creation of a single, coherent communication system is a very difficult task for both side - the organizational as well as technical. Very often to reach from one area of the agglomeration to another it requires the use of the services provided by different carriers, or make interchange between 2 or 3 means of transport organized by a single carrier.

Fig. 1. Area of KZK GOP activity [24]

2. BOBROWNIKI RURAL COMMUNE

Bobrowniki rural commune is situated in the northern part of the Katowice conurbation, and as shown in figure 2 adjacent the municipalities such as Mierzęcice, Psary and Wojkowice.

Fig. 2. Location of the Bobrowniki rural commune on the background of neighboring municipalities. [26]

According to the data of the municipal office Bobrowniki [26], the surface of the municipality is 52 km², and the population as of 31.12.2015 amounted to 11 663 people, including:

- to 9 years - 1 102 people
- from 10 to 19 years - 1 054 people
- from 20 to 29 years - 1 329 of
- from 30 to 39 years - 1 946 people
- from 40 to 49 years - 1 615
- above 50 years - 4 895 people.

The resident's age characteristics of the municipality are also shown in Figure 3.

Fig. 3. The resident's age characteristics of the Bobrowniki rural commune.

As shown from the above data and Figure 3 commune is inhabited mainly by young people and people in "productive" age. Also for this reason it is essential that the Bobrowniki rural commune had a convenient connection to collective communication with the capital of the region and the province.

The commune is located in the northern part of the activities of KZK GOP, as shown in Figure 4 (red indicated the commune Bobrowniki and yellow Katowice city).

Fig. 4. Localization of Bobrowniki rural commune on KZK GOP activity area [24]

In order to realize a trip to Bobrowniki from Katowice We must use a minimum of 2 buses, between which We have to change in Kamień or in the center of Bytom city. An example of a route of travel from Katowice to Bobrowniki with change in Kamień is shown in Figure 5.
Fig. 5. The route from Katowice to Bobrowniki with a change in Kamień using bus public transport offered by KZK GOP [25]

In contrast, Figure 6 shows the route of travel from Katowice in the direction to Bobrowniki with a change in Bytom city.

Figure 6. The route from Katowice to Bobrowniki with a change in Bytom city using bus public transport offered by KZK GOP [25]

The journey from Katowice to Bobrowniki is possible with the use of several different connections, but the carrier on its website, using the search engine, suggests to take advantage of the following preferred connections:

- Bus 830 to Bytom, and then change to a bus 85 in the direction of Bobrowniki;
- Bus 5 to Kamień, and then change to a bus 85 in the direction of Bobrowniki;
- Bus 860 to Kamień, and then change to a bus 85 in the direction of Bobrowniki;
- Bus 830 to Bytom, and then change to a bus 85 in the direction of Bobrowniki.

A very important element facilitating the journey is the lack of need to change the bus stop, at which the change of buses is made.

3. RESEARCH METHODOLOGY

As part of the study were analyzed the plates of bus routes, bus trips and web applications provided by KZK GOP, whose task is the ability to search a connections. Studies presented below are an extension of the research described in [11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21] of the connections made to other popular in the region connections relationship. The following article describes the number of connections and the transfer time to the line 85 to the carrier from Katowice to Bobrowniki with the necessity of change in Bytom or Kamień.

The studies were obtained arrival times of buses KZK GOP line 5 and 860 to Kamień bus stop and times of departure line KZK GOP 85 from the bus stop, as well as times of arrivals line KZK GOP 830 to Bytom Dworzec PKP bus stop and departure times of buses KZK GOP line 85 from this stop in the direction to Bobrowniki.

The following Tables 1 to 3 shows a comparison of KZK GOP Line 5, 830 and 860 arrivals time with times of line KZK GOP 85 departures. In Tables 1 to 3, blue color indicated waiting time amounting to more than 30 minutes, while red indicated time expectation equal to 5 minutes or less - it is a short waiting time, for which there is a high risk of being late for buses going in Bobrowniki direction due to the delay in the timetable of the first bus. Purple color indicated a situation in which a bus in the direction of Bobrowniki departs just before the arrival of the bus from Katowice.

Tab. 1. Analysis of the waiting time between KZK GOP 5 & KZK GOP 85

<table>
<thead>
<tr>
<th>Arrival of KZK GOP 5 on Kamień Bus Stop</th>
<th>Departure of KZK GOP 85 from Kamień Bus Stop</th>
<th>Waiting time [min]</th>
<th>Arrival of KZK GOP 5 on Kamień Bus Stop</th>
<th>Departure of KZK GOP 85 from Kamień Bus Stop</th>
<th>Waiting time [min]</th>
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The average waiting time for KZK GOP 860 is 8 minutes, while for KZK GOP 85 the average waiting time is 5 minutes. The average waiting time for KZK GOP 860 is almost 12 minutes, which is beneficial to passengers because they choose earlier connections.

In accordance with the data in Table 3 for 28 arrivals KZK GOP bus line No. 830 change is possible for 13 connections with buses KZK GOP 85. The average waiting time - without considering the connections that require long waiting - is 11 minutes, but in the extreme case this time be up to even 4 hour and 17 minutes.

The above data on the possible number of transfers apply to all possible connections, but how it is presented in Tables 1 to 3, buses going from Katowice to Kamięń or Bytom run more frequently than buses to Bobrowniki, so a large number of connections won’t benefit by passengers because they choose earlier connection to continue their journey.

Also very important is difference during a trip undertaken using public transport and individual transport (car). Travel by public transport takes about 1 hour to 1 hour 30 minutes, by individual transport the same route is carried in a period of about 30 minutes. The information contained in Tables 1 to 3 relating to waiting times and the number of connections, together with their percentage share in relation to the timetable of the bus line KZK GOP 85 are shown in Table 4.

In accordance with the information given in Table 4 connections are possible for almost every bus line KZK GOP 85. Percentage of possible connections in each case is equal or above 40%, which according to the author is not such a bad result (note that the data in Table 4 which is mentioned do not include connections that require long waiting). Unfortunately analyzing Tables 1 to 3 can be seen that the bus line KZK GOP 85 hasn’t got connections in the very late evening (after 22:10). The last bus line 5 arrives from the Katowice to Kamięń at 23:59 and last bus line 860 arrives from the Katowice to Kamięń at 23:19, while the bus line 85 departs from the Kamięń at 22:31. A different situation we have in the case of line 830. For the last 85 bus lines there are no connections from Katowice, the last bus line 830 arrives at Bytom Dworzec PKP at 17:25 (no connections from Bytom Dworzec PKP to Bobrowniki after this time).

Figure 7 shows the percentage of connections for KZK GOP 85 from the other lines, while Figure 8 and 9 shows the waiting times to change buses between the line KZK GOP 85, and lines KZK GOP which drive from the center of Katowice.
Fig. 7. The percentage of connections on KZK GOP 85 from the other lines which drive from the center of Katowice.
Source: Own calculations based on Table 4.

Fig. 8. Number of connections and waiting time for connection from the buses which goes from Katowice to the Kamień Bus Stop to make change on line KZK GOP 85.
Source: Own calculations based on Table 1 ÷ 2.
The waiting time for connection on the line KZK GOP 85 from the buses KZK GOP 830 which goes from Katowice to the Bytom Dworzec PKP Bus Stop to make change on line KZK GOP 85.

Source: Own calculations based on Table 3.

**SUMMARY**

Implementation of connections with the Katowice and Bobrowniki rural commune using the line KZK GOP 85 and proposed by the carrier lines 5, 830 and 86 is realized in a pretty good manner. Noteworthy is the fact that there are quite a large number of possible connections and the average waiting time is not too long. Unfortunately, the proposed connections have also some elements which require further elaboration. A large number of connections are with waiting time of less than 5 minutes or longer then 30 minutes, which may discourage the use of public transport. The main problem observed by the author is a travel time by public bus transport which in the extreme case is almost two times longer than in the case of individual transport.

Therefore, according to the author, KZK GOP should consider a slight modification of the proposed timetables (to make waiting time more comfortable for passenger – it should be about 10 ÷ 15 minutes). The second important thing is that carrier company should increase the traveling speed of buses (mainly on the route Katowice – Bytom or Katowice - Kamień), so that the travel time was comparable to the driving using individual transport.

Those actions should contribute to the gradual ever greater interest in the use of public transport instead of individual transport.

**BIBLIOGRAPHY**

11. Sobczak P.: Analiza realizacji transportu zbiorowego pomiędzy gminą Bobrowniki a miastem Katowice z wykorzystaniem komunikacji autobusowej organizowanej przez KZK GOP, Cza...


Analiza realizacji transportu zbiorowego pomiędzy miastem Katowice a gminą Bobrowniki z wykorzystaniem komunikacji autobusowej organizowanej przez KZK GOP

Organizacja transportu zbiorowego stanowi istotny element polityki zrównoważonego transportu danego regionu. Jest to szczególnie istotne i ważne podczas organizacji transportu na obszarach o wysokim stopniu urbanizacji, jak np. Aglomeracja Górniośląska. W artykule przedstawiono analizę połączeń organizowanych przez KZK GOP na trasie umożliwiającej dojazd z Katowic do jednej z mniejszych miejscowości (Gmina Bobrowniki) zlokalizowanych na terenie Aglomeracji Górniośląskiej.

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