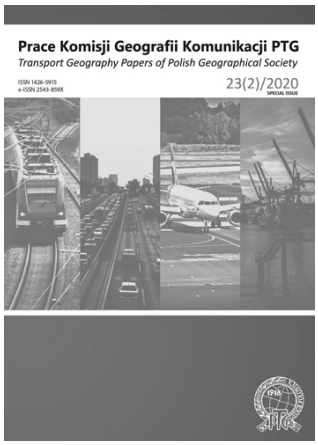

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RESTRICTIONS ON REGIONAL PASSENGER TRANSPORT DURING EPIDEMIOLOGICAL THREAT (COVID-19) – AN EXAMPLE OF THE LOWER SILESIAN VOIVODSHIP IN POLAND

Ograniczenie regionalnych przewozów pasażerskich podczas zagrożenia epidemiologicznego (COVID-19) na przykładzie województwa dolnośląskiego

Mateusz Smolarski

Department of Geography and Landscape Management, Institute of Socio-Economic Geography and Spatial Management, Faculty of Economy, University of Opole, Ozimska 46a, 45-058 Opole, Poland

e-mail: mateusz.smolarski@uni.opole.pl

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Abstract: The beginning of 2020 was associated with the appearance of the global coronavirus pandemic (COVID-19). The spread of the epidemic caused the introduction of an epidemiological emergency in Poland in early March (on March 12). This resulted in reduced public transport, including regional rail transport. In Lower Silesia, this concerned regional and fast connections. The conducted analysis concerns regional connections and is based on exploration of the spatial and the quantitative aspect of these changes. The transport offer before and after the announcing of the epidemic was analysed. The results showed that most of the transport restrictions concerned the peripheries of the voivodeship (local routes). Agglomeration routes were much less affected by the restrictions. On some lines a decrease to less than 5 pairs of connections per day was recorded. Once the restrictions are removed, it may be a challenge to encourage passengers to use railways again. Despite the low number of connections on many routes, rail transport can still be considered as the basis of the transport system. This is due to the lack of an alternative bus service.

Keywords: COVID-19, railway transport, Lower Silesian Voivodeship; public transport

Introduction

The global socioeconomic situation, transport flows, migrations, citizens' health status, global and local tourism are some of the basic elements of the functioning of today's world. Their existence can be disturbed by an external factor. At the turn of 2019/2020, the appearance of the COVID-19 virus (coronavirus) in China was such a global stimulus. The epidemic was transferred to Europe in early January, and the first cases of infection were confirmed on January 25, 2020. Since then, a growing number of infected persons have been identified. The World Health Organization (WHO) announced a global pandemic on March 11. On March 4, the first case of infection in Poland was announced in a resident of Zielona Góra. Such a rapid increase in the number of patients and the spread the virus resulted in the introduction of the state of epidemiological threat in Poland on March 12 (gov.pl/koronavirus).

Crisis activities in Poland were related to the introduction of a number of restrictions, including: a possibility of movement, a ban on gatherings, closing shops, restriction of access to green areas and forests, and suspension of activity of educational establishments. Domestic and international rail connections for regular passenger traffic were completely suspended. Ultimately, passenger rail transport showed a significant drop in the number of passengers and connections made.

1. Literature review

It can be assumed that there are a number of factors that interfere with public transport. External causes include epidemics, collapses of world trade markets, catastrophic meteorological phenomena, closing state borders, or natural disasters. In turn, internal aspects include: breaking down of the rolling stock, employees' diseases, administrative difficulties, loss of financial liquidity.

The transport system affects the functioning of society and the economy. Undoubtedly, transport should also be recognised as a factor influencing the change in behaviour and mobility of the society. This can have both a positive and a negative impact on public health.

The problem of correlations between the functioning of transport (both public and private) and health protection is very extensive and concerns many aspects of everyday life and the global economy (Wnukowski, 2020). Efficient transport systems can be a factor accelerating the spread of a virus on a global scale (Ruan et al., 2019; Rodrigue et al., 2016). It can be assumed that the more efficient transport is, the more efficiently diseases and infections spread (Rodrigue et al., 2016). In general, from among all modes of transport, air transport is considered to have the greatest impact on the pace of spreading an epidemic. An increase in the significance of tourism and mobility has significantly affected the likelihood of a pandemic in recent years (Sonmez et al., 2019).

The course of the spatial expansion of an epidemiological phenomenon can be presented in 4 stages (Fig. 1). The first one (Fig. 1, A) is associated with the emergence of a threat at a local level. Individuals are at risk in limited space (e.g. in one city). If there is a larger transport hub nearby, it comes to the second phase (Fig. 1, B) – an initial transfer. In this situation, the infection spreads to other areas, and infected persons do not yet show symptoms (the virus is in the period of incubation). It should be noted that epidemic translocation is mainly based on the structure of transport and social connections, and not only on the basis of geographical proximity. Phase 2 can lead to disease clusters that are still manageable. In the next stage (Fig. 1, C), there is a diffusion of the hazard on an even larger scale, and restrictions in transport connections and human flows are introduced (e.g. restrictions on crossing borders). Actions are implemented to flatten the number of infections. The last stage (Fig. 1, D) is associated with a global pandemic,

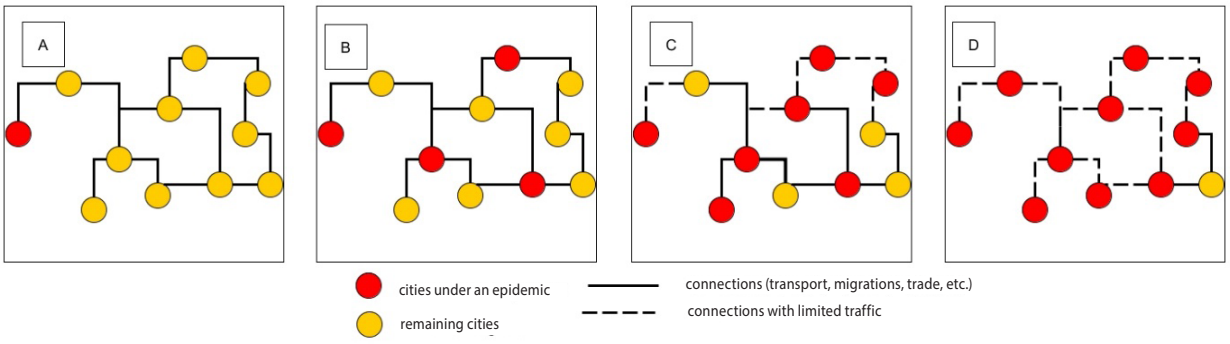

Fig. 1. A simplified diagram of the expansion of an epidemiological threat.

Source: own work based on Epstein et al. (2016), Rodrigue et al. (2016).

where only individual areas of the world are free from infection.

Yet, public transport also has a positive impact on public health (Durand et al., 2016; Litman 2012, 2013; Sonmez et al., 2016). The main benefits of using public transport and active forms of movement (e.g. on foot) include (Durand et al., 2016; Litman, 2012; Liao et al., 2016): a decrease in the number of car accidents, an increase in physical activity, enhanced mental health, better accessibility of services for people without their own cars and a decrease in the percentage of obese people.

One of the studies on the relationship between rail transport and the phenomenon of the spread of infections and epidemics was the analysis by Fox et al. (1991). The subject of the study was the development of a malaria epidemic in Ethiopia. Particular attention was paid to the role of rail transport as a factor affecting the transfer of the epidemic to nearby Djibouti. A similar analysis conducted by Evans (1988) concerned the cholera epidemic in Europe in the 19th century. In the case of the Spanish flu epidemic, research was carried out into the impact of the South African rail system on the development of this threat (Hogbin, 1985).

Studies on the development of coronavirus in China have shown that there is a positive correlation between the frequency of flights and the running of buses and trains, and the number of reported COVID-19 cases (Zhen et al., 2020).

Studies on the functioning of rail transport may also concern the impact of natural (atmospheric) factors. As research by Kvizda and Seidenglanza (2014) showed, after the volcanic eruption in 2010, there was a complete suspension of air traffic in Europe. Therefore, travellers used rail transport as an alternative means of transport. 20% of passengers traveling from Prague to nearby countries switched to trains (Kvizda, Seidenglanz, 2014). Another study concerned the impact of weather conditions on the operation of rail transport in Dublin. It was shown that the main factors disrupting the transport process include storms and squalls (Brazil et al., 2017).

2. Research area, purpose and research methods

The research area covers Lower Silesian Voivodship[1] (Fig. 2, A), and its subject concerned passenger connections carried out by Przewozy Regionalne (PR) and Koleje Dolnośląskie (KD) railways. The purpose of the analysis was to assess changes in the spatial operation of rail transport after the introduction of the state of epidemiological threat in Poland.

The actual railway network has been transformed into a network layout (Fig. 2, B) based on 36 nodes and edges corresponding to particular railway lines. Stations from which passenger traffic is operated in at least 3 directions (12 stations of this type) were considered as nodes. In addition, the so-called end nodes were included, i.e. the nodes located on the borders

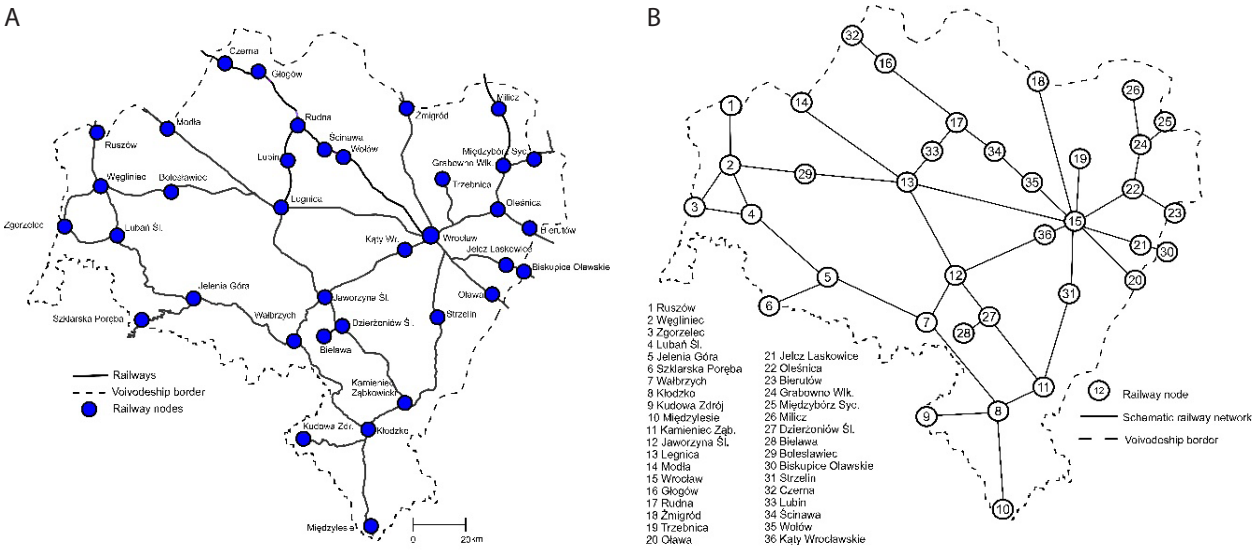

Fig. 2. Layout of railway lines (A), network layout of railway lines in Lower Silesian Voivodeship (B).

Source: own work.

[1] In the analysis, the author will use the terms Lower Silesian Voivodeship and Lower Silesia as synonymous terms. However, he is aware that in spatial terms, they do not cover exactly the same area.

of the network in question[2] (15). Furthermore, the author decided to recognise as nodes those railway stations where passenger trains end their journey (8)[3].

The study was based on the evaluation of the transport offer in the 2019/2020 timetable and the offer introduced in the face of the epidemiological threat[4] (after limiting the number of rides). Data on timetables and transport restrictions was obtained from the carriers' official websites[5].

3. Analysis of the transport offer

The analysis showed that of all the introduced changes, in the vast majority of cases, decisions were made to cancel the connections and to shorten the route (116 in the case of KD and 88 for PR). The introduction of extended lines on routes operated by Koleje Dolnośląskie Railways was an interesting phenomenon. Along with introducing restrictions on certain routes, this carrier decided to extend 9 routes to compensate for the restrictions in some way. Another form of restriction was limiting the dates of travel for 12 connections (e.g. from daily to selected days of the week). The introduction of Substitute Bus Service (18 connections) was probably caused by reduced human resources (child care leave, sick leave, etc.).

The assessment of the phenomenon of transport restrictions in the daily timetable by hour was an interesting issue. Strong dominance of the morning and afternoon peak times was identified. This is due to the fact that during this period there are relatively the most connections (especially within the Wrocław agglomeration), and a possible reduction in the transport offer would not be so burdensome for passengers. The lowest percentage of cancelled rides was found in the late evening (after 9 p.m.). At this time, rail transport is probably the only available transport option[6].

The main part of the analysis covered the functioning of rail transport (Fig. 3) before introducing the restrictions (Fig. 3, A) and after taking the restrictions into account (Fig. 3 B, C).

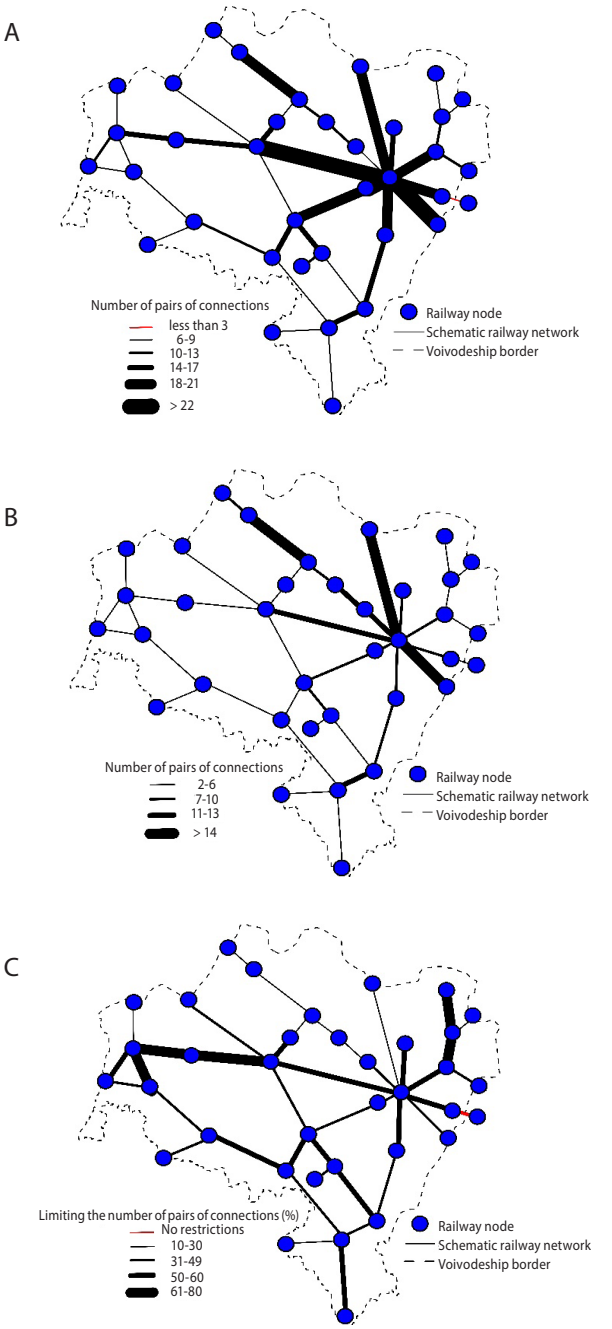

Fig. 3. Transport offer in Lower Silesian Voivodship (A) before introducing changes, after introducing restrictions (B) and the percentage of suspended connections (C). Situation as of April 20, 2020.

Source: own work.

[2] The study based on both transfer and dead-end stations was proposed, among others, by Derrible, Kennedy (2010).

[3] Głogów, Jelcz Laskowice, Bolesławiec, Lubin, Ścinawa, Wołów, Strzelin, and Kąty Wrocławskie. Extending the set of nodes by a station resulted from the author's intention to create an extended network system based on the actual system of connections (rail connections).

[4] The author considered 2 versions of the timetables: 16 March (before introducing changes) and 20 April (introducing changes to the transport offer).

[5] Data on the transport offer are currently mainly published on-line using dedicated websites and timetable search engines (Jurkowski, Smolarski, 2016). In recent years, social media have played an increasingly important role in this respect. They are very often used to disseminate the latest information during possible transport disruptions. Information about delays and disruptions is part of providing digital services on trains (Drewnowski, Małachowski, 2018).

[6] This is noticeable e.g. in the case of evening long-distance connections to Wrocław. In the face of bus traffic restrictions, rail transport is an alternative to travel to destinations located outside the voivodeship capital

The original arrangement of communication links is mainly based on the most important communication routes in the region (Fig. 3, A). These are the lines connecting, among others, Wrocław with Legnica, Jaworzyna Śląska, Oława (and then Opole), and Żmigród. The most connections were identified between Wrocław and Legnica (29 pairs a day), Oława (23) and Kąty Wrocławskie (23). The dominance of the voivodeship capital as the most important node in the region is visible[7]. It concentrates both regional transport (e.g. from Węgliniec, Szklarska Poręba) and the local, agglomeration one (e.g. transport from Trzebnica or Oleśnica). The section of Oława – Wrocław – Legnica – Węgliniec – Zgorzelec can be considered the main skeleton of communication links, where the average number of connection pairs per day reaches as many as 29 pairs per day. It is worth noting that prior to electrification of the Węgliniec – Zgorzelec section, trains running from Wrocław and Legnica finished in Węgliniec. Further travel was possible after a transfer. Currently, it is possible with a use of direct connections from Wrocław.

The lines located on the western and eastern peripheries of the voivodship have a definitely less developed transport offer (usually between 6 and 9 pairs of connections per day). This applies, among others, to routes from Kłodzko to Wałbrzych (6), from Kłodzko to Kudowa (7) and from Lubań to Zgorzelec (7). In the case of routes located around the Wrocław agglomeration, the smallest number of connections was found on the section from Oleśnica to Krotoszyn and Ostrów Wielkopolski. The worst transport offer in the whole voivodeship is on the route from Wrocław to Opole, via Jelcz Laskowice. 2 pairs of connections run daily from Jelcz to Opole (the situation has been like this for many years).

The analysis of the offer after the introduction of restrictions in mid-April showed significant changes in the level of transport services in the region. Considering the communication system functioning in the regime of restrictions (Fig. 3, B), one strong transport system based on Wrocław is visible. It mainly includes the following routes: Wrocław – Legnica, Wrocław – Żmigród, Wrocław – Wołów and Wrocław – Oława – (Opole). On these routes, the number of connection pairs is more than 11 per day. It seems that this level can be considered as the necessary minimum[8].

A strong concentration of transport was also identified on the Rudna Gwizdanów – Głogów section, but the reason for this was the overlap of connections from different destinations (Wrocław – Legnica – Lubin – Głogów and Wrocław – Wołów – Głogów). The remaining part of the rail network in the region was severely affected by restrictions. Practically, the number of connection pairs was at the level of 6 per day on every route except the Wrocław agglomeration. The study showed that on some sections the level of communication services was less than 4 pairs a day (e.g. Grabowno Wielkie – Międzybórz, Lubań Śl. – Węgliniec, Oleśnica – Milicz).

Given a decrease in the number of connections in relative (percentage) terms, strong spatial polarization is visible (Fig. 3, C). The sections with the largest reductions in the transport offer are: Legnica – Węgliniec (a decrease by 61%), Węgliniec – Zgorzelec (50%), Oleśnica – Milicz (71%), Jaworzyna Śląska – Wałbrzych (60%), Wałbrzych – Jelenia Góra (53%). The analysis showed that the relatively smallest declines were identified within the Wrocław agglomeration (e.g. a decrease of 25% on the route to Żmigród). The largest relative declines around Wrocław were identified on the routes to Jelcz Laskowice (54%), Trzebnica (56%) and Oleśnica (50%). On the regional scale, the Wołów – Głogów section belongs to the routes where the transport offer was reduced the least (about 17%).

Summary

The study showed that the introduced restrictions concerned the entire area of Lower Silesia. However, it is possible to define a line where the changes were most intense. The largest relative decline in the level of transport services was found in the western periphery of the voivodeship (e.g. Jelenia Góra – Wałbrzych) and on some lines within the Wrocław agglomeration (e.g. from Wrocław to Trzebnica). However, it should be clearly stated that the declines around Wrocław concerned single routes, and the entire railway system is still an important basis for public transport. A decrease in the number of connections on other sections may constitute a threat of the deepening transport exclusion. In some cases, the decrease in the level of transport services applies to lines where even before the epidemic bus transport was practically non-functional (e.g. Legnica – Węgliniec).

The spatial structure of the communication system was preserved before and during the epidemic. Large transport generators include lines concentrating in Wrocław. In turn, local and regional routes were characterised by a relatively low level of transport service. Transportation is mainly based on the main routes in the region, especially around Wroclaw.

[7] Wrocław was the most important hub in the region in terms of both bus and rail transport as early as in 2016 (Jurkowski, 2016). In the case of other stations, the most important generators of the number of connections and passenger traffic should include: Legnica, Wałbrzych, Kłodzko, Oleśnica, Głogów (Jurkowski, Smolarski, 2018).

[8] Seven pairs of connections a day can be considered as the necessary minimum to create a transport offer at a level satisfactory for passengers (Majewski, 2006).

These are routes with the highest transport potential in Lower Silesia.

The introduced changes in transport in terms of the time of operation of individual trains concentrated in the morning and the afternoon peak periods. The cancellations concerned the time of day when the frequency of operation is the highest and the limitation of the transport offer is the least problematic for passengers. Transport restrictions were most often associated with the total suspension of connections; the cases of limiting running dates were sporadic. The introduced changes were often a result of previously planned rolling stock cycles or possible staffing problems (e.g. due to sick leave).

Rail transport in rural and peripheral areas (e.g. Kłodzko Land, around Zgorzelec and Jelenia Góra, inter-voivodship lines) after significant reductions in transport is the communication skeleton of the region. It is caused by very intense (almost total) liquidation of bus transport (e.g. by PKS [coach service provider] in Kłodzko and Jelenia Góra). The Kłodzko – Międzylesie railway line can be an example of such a situation, where bus transport had been relatively low already before the epidemic. Currently, the train offer is based on 4 trains a day. The use of rail transport is the only way to travel for residents, apart from individual transport.

Undoubtedly, after the epidemic, rebuilding passenger confidence in railways will become a major challenge. Suspension of transport from one day to the next has become a reason to look for an alternative way of commuting. After returning to the normal functioning of the state, reconstruction of the entire communication system based on an attractive transport offer will be necessary. An initial reduction in train fares may also be an option to encourage passengers to return. The worst possible solution would be a return to the individual transport paradigm as the basis for transport.

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