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# Rail Transport Infrastructure as a Factor Accessibility of Rail Transport on the Example of Poland

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***Abstract:***

***Purpose:*** *The article presents the impact of changes in the length of rail transport infrastructure in Poland on the regional availability of rail transport.*
***Design/methodology/approach:*** *The time analysis covers the period from 2000 to 2020. During the period under study, the length of railway lines in Poland was shortened, which should be associated with the socio-economic changes that took place in Poland after 1989. This situation was influenced by several factors: socio-economic changes, changes in the principles of organizing railway transport, the growing role of transport user preferences, changing transport behavior of the population and growing access to passenger cars.*
***Findings:*** *The article is of a theoretical and empirical nature. The theoretical layer presents an overview of the scientific achievements regarding the role of public transport in socio-economic development and the issues of transport accessibility. The empirical layer presents changes in the length of railway transport lines and the spatial and demographic assessment of the density of railway transport lines in Poland from a regional perspective. On this basis, a weighted average indicator was determined reflecting changes in the availability of bus services in Poland. The calculations are presented for the period 2000-2020 by country and region.*
***Practical implications:*** *The reduction of railway lines reduces access to rail transport in Poland. First of all, it results in reduced accessibility to rail transport services for residents. This has a negative impact from a social point of view, limiting the mobility options of people without access to passenger cars. Negative effects also have economic and environmental dimensions (higher environmental costs).*
***Originality/Value:*** *The results contribute to the discussion on the development of rail transport infrastructure in the context of improving transport accessibility. Infrastructure development plans should take greater account of general megatrends taking place in society. Due to the lack of new investments (or their small number) related to the development of infrastructure, population growth negatively affects the level of transport accessibility and thus worsens the quality of life of residents.*

***Keywords:*** *Transport availability, rail transport infrastructure.*

***JEL codes:*** *R410.*
***Paper Type:*** *Case study.*

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## 1. Introduction

The model of state development adopted in Poland after 1989, was associated, inter alia, with the reduction of interference with socio-economic processes. Importantly enough, the social perception of transport changed. It was no longer treated as a public service.

The process of systemic transformation in Poland was related, among others, to the sphere of railway transport, including the approach to railway transport infrastructure. Since 2001, PKP PLK SA has been responsible for managing the railway transport infrastructure in Poland.

Currently, the largest shares in the company are held by the State Treasury (82). The minority shareholder is PKP S.A. (18%) (Raport roczny…).

The aim of the article is to present the change in the length of rail transport infrastructure on the level of availability of this branch of transport at the national and regional level. The key to the analysis was the calculation of demographic and spatial density indicators and the sustainable development index. The scope of the analysis covered the years 2000-2020.

## 2. The Role of Transport Infrastructure in Socio-Economic Development - Literature Studies

The role of transport infrastructure is evidenced by such general concepts as the "blood circulation" of the general population and the economy (Grzywacz and Burnewicz, 1989). Transport infrastructure causes numerous positive effects, including socio-economic and environmental ones (Majewski, 2021).

In the social aspect, transport infrastructure ensures territorial cohesion and, by ensuring mobility, determines the standard of living of the population, satisfying their natural need for mobility, social satisfaction, and also reduces social exclusion (Panda and al – eds, 2022).

Reducing the length of railway lines results in the inability to meet mobility needs, which in turn leads to a reduction in the scope of transport services offered by passenger carriers and contributes to the development of social exclusion (Preston and Raje, 2007; Stanchev and Menaz, 2003).

It causes negative consequences, such as deterioration of the quality of life, financial status, reduced opportunities for self-development, limited choice of goods, products and jobs (Kenyon, Lyons, and Rafferty, 2002; Kadlubek *et al.*, 2022a; 2022b).

Research connected with the impact of transport infrastructure on socio-economic development concerns:

a) time of travel - quantitative growth and qualitative development of transport infrastructure reduce travel time;
b) costs of transport – the development of infrastructure improves the investment attractiveness of a given area, capital productivity, it contributes to technical progress;
c) efficiency of the transport process - the transport infrastructure impacts on the progress of the transport process, and directly affects the efficiency of manufacturing companies and household budgets (e.g., lower operating costs of passenger cars).

The development of transport infrastructure is particularly relevant in the less-developed regions. This thesis is confirmed by assigning different weights to transport infrastructure as a factor shaping the competitiveness of the region. Of value are reports presented by the IMD – *International Institute for Management Development* and the WEF – *World Economic Forum*, where transport infrastructure is among the basic requirements that shapes the competitiveness of a given area (most often a country) *(The Global Competitiveness…)*.

In the social dimension, the role of transport infrastructure stems from its function as a determinant of social mobility. Thanks to ensuring spatial connections, the transport infrastructure enables access to jobs, science, health care and culture.

On the wider stage, transport infrastructure positively impacts the leveling of social disproportions in regional terms. As K. Wojewódzka-Król notes, the development of transport infrastructure may also contribute to mitigating the implications of unemployment (Wojewódzka, 2018).

In the spatial aspect, the transport infrastructure influences, inter alia, the mobility of inhabitants as well as the market of goods and services. Its improvement allows the inhabitants (at the same time) to cover a greater distance.

On the other hand, for market entities it means the possibility of reaching more customers. Owing to better transport infrastructure, producers can offer their products in a wider area.

In environmental terms, attention is drawn to the role of transport infrastructure in reducing external costs of transport. Improving transport infrastructure could contribute to constraints related to the reduction of pollutant emissions and noise.

Limited mobility caused by limited access to rail transport services has negative social consequences. It may contribute to the creation and deepening of social divisions, especially as a result of reduced accessibility of areas such as education, health or work (Sustainable Urban…, 2000). Additionally, limiting access to public transport forces a change in the pattern of everyday mobility.

This applies, among others, to the rural population, for whom the liquidation of railway transport lines had a negative impact on spatial mobility (Social effects...). Social exclusion most affects children and young people, as well as elderly and lonely people, especially those without a driving license or a car.

From an economic point of view, it is a necessary condition for meeting transport needs, taking into account the spatial distribution of settlement centers and the need to travel distances for various purposes (Domańska, 2004).

Thanks to the development of transport infrastructure and the simultaneous use of tools that reduce the attractiveness of using individual transport (e.g., financial, legal tools), the development of individual motorization can be inhibited. A good example are the solutions operating in many cities in Western Europe.

## 3. The Impact of Transport Infrastructure on Transport Accessibility

Transport infrastructure affects transport accessibility (Tolley and Turton, 2014; Measuring What Matters, 2010). Transport accessibility in the context of transport infrastructure shapes the quality of life of residents (Pred, 1977). Being able to access more of these areas provides a sense of improved quality of life.

An interdisciplinary approach can be taken into account in the analysis of transport accessibility. For example, from a spatial and economic perspective, we can point to the factor of transport infrastructure, which affects both systems by changing resistance factors (distance, time, cost).

Territorial cohesion is a vital area in assessing the level of transport accessibility, for which the base is the transport infrastructure (linear and nodal). This is important for peripheral areas of the country, regions (peripheral) that are socially or economically backward.

That view is supported by K. Spiekermann and M. Wegner, according to whom transport infrastructure enables spatial interaction and improves social cohesion (Spiekermann and Wegner, 2012).

In addition to the quantitative approach, the quality of transport infrastructure is also key for the analysis of transport accessibility, which affects the course of the transport process, the level of safety, duration of movement, energy consumption, which in turn translates into a lower environmental burden.

A special role is played by communication stops, including their location, technical aspects (e.g., the degree of their adaptation to the means of transport – platform height) as well as the quality, legibility and timeliness of timetables. In this theory, infrastructure influences the temporal and economic scope of transport accessibility.

## 4. Transport Accessibility of Railway Transport Infrastructure in Poland in 2000-2020

The length of rail transport infrastructure in Poland shows a downward trend (Table 1). Reducing the length of railway lines results in an increase in the area without access to rail transport. This situation has a negative impact on the availability of transport services, which has definitely determined.

***Table 1***. Changes in the length of railway lines in Poland and regions between 2000 and 2020

| Item | 2000 | 2010 | 2020 | 2020:2000 |
|---|---|---|---|---|
| **Polska** | **21073** | **20228** | **19 422** | **-8%** |
| Dolnośląskie | 1 797 | 1779 | 1 776 | -1% |
| Kujawsko-pomorskie | 1 312 | 1258 | 1 199 | -9% |
| Lubelskie | 1 100 | 1041 | 1 093 | -1% |
| Lubuskie | 915 | 967 | 913 | 0% |
| Łódzkie | 1 135 | 1059 | 1 080 | -5% |
| Małopolskie | 1 143 | 1131 | 1 080 | -6% |
| Mazowieckie | 1 701 | 1709 | 1 716 | 1% |
| Opolskie | 859 | 867 | 784 | -9% |
| Podkarpackie | 999 | 1024 | 978 | -2% |
| Podlaskie | 682 | 763 | 759 | 11% |
| Pomorskie | 1 325 | 1238 | 1 212 | -9% |
| Śląskie | 2 269 | 2140 | 1 872 | -17% |
| Świętokrzyskie | 722 | 721 | 722 | 0% |
| Warmińsko-mazurskie | 1 326 | 1238 | 1 091 | -18% |
| Wielkopolskie | 2 158 | 2091 | 1 881 | -13% |
| Zachodniopomorskie | 1 222 | 1202 | 1 170 | -4% |

***Source:*** *Own analysis: Transport – wyniki działności 2000-2020, GUS, Warszawa 2001-2021.*

According to the data presented in Table 1, in Poland in the years 2000-2020 the length of active railway lines decreased by 8%. However, in regional terms, the changes were varied. In two voivodeships, Podlaskie and Mazowieckie, the length of active railway lines increased, in two it remained unchanged.

However, in as many as 12 years there was a decrease in the length of railway lines. The length of railway lines decreased the most in the Warmińsko-Mazurskie and Wielkopolska voivodeships, by 18% and 13%, respectively.

## 5. The Impact of Changes in the Length of Railway Lines on the Availability of Rail Transport in Poland

The research methodology for determining changes in the level of transport accessibility in regions influenced by the length of railway transport lines included two indicators:

1. Spatial density index taking into account the length of transport routes and the area (of the country and of the provinces),
2. Demographic density index taking into account the length of transport routes to the number of inhabitants of the region (country and provinces)

Changes in the spatial and demographic density indicators of rail transport infrastructure are presented in Table 2.

***Table 2.*** *Changes in the spatial and demographic density of railway transport infrastructure in Poland in the years 2000-2020*

| Item | **Spatial density** (length of railway lines in km /100 km$^2$) | | | | **Demographic density** (length of railway lines in km/10000 inhabitants) | | | |
|---|---|---|---|---|---|---|---|---|
| | **2000** | **2010** | **2020** | **2020:2000** | **2000** | **2010** | **2020** | **2020:2000** |
| **Polska** | 6,73 | 6,41 | 6,22 | -8% | 5,50 | 5,24 | 5,05 | -8% |
| **Dolnośląskie** | 8,95 | 8,95 | 8,95 | 0% | 5,87 | 5,91 | 5,86 | 0% |
| **Kujawsko-pomorskie** | 7,65 | 7,06 | 6,47 | -15% | 6,29 | 5,80 | 5,31 | -16% |
| **Lubelskie** | 4,80 | 4,00 | 4,00 | -17% | 5,48 | 4,64 | 4,74 | -13% |
| **Lubuskie** | 6,92 | 6,92 | 6,92 | 0% | 8,93 | 8,91 | 8,90 | 0% |
| **Łódzkie** | 6,11 | 5,56 | 5,56 | -9% | 4,24 | 3,94 | 4,07 | -4% |
| **Małopolskie** | 7,33 | 7,33 | 6,67 | -9% | 3,38 | 3,34 | 2,93 | -13% |
| **Mazowieckie** | 4,86 | 4,86 | 4,86 | 0% | 3,31 | 3,26 | 3,13 | -5% |
| **Opolskie** | 8,89 | 8,89 | 7,78 | -13% | 7,58 | 7,76 | 7,13 | -6% |
| **Podkarpackie** | 5,29 | 5,88 | 5,29 | 0% | 4,29 | 4,76 | 4,23 | -1% |
| **Podlaskie** | 3,00 | 3,50 | 3,50 | 17% | 4,98 | 5,89 | 5,94 | 19% |
| **Pomorskie** | 7,22 | 6,67 | 6,67 | -8% | 5,94 | 5,38 | 5,12 | -14% |
| **Śląskie** | 18,33 | 16,67 | 15,00 | -18% | 4,67 | 4,32 | 3,98 | -15% |
| **Świętokrzyskie** | 6,36 | 6,36 | 6,36 | 0% | 5,42 | 5,51 | 5,68 | 5% |
| **Warminsko-mazurskie** | 5,42 | 5,00 | 4,17 | -23% | 9,10 | 8,41 | 7,03 | -23% |
| **Wielkopolskie** | 6,90 | 6,90 | 6,21 | -10% | 5,95 | 5,87 | 5,15 | -14% |
| **Zachodniopomorskie** | 5,45 | 5,45 | 5,00 | -8% | 7,08 | 7,09 | 6,49 | -8% |

***Source:*** *Own analysis based on: Results of transport operations.*

The deterioration of the spatial and demographic density indicators of railway lines limits the availability of railway transport services. It should be noted, however, that from a regional perspective, there are voivodeships where no deterioration of spatial and demographic accessibility has been recorded. An example of a voivodeship where transport accessibility has not deteriorated in spatial terms is the Lower Silesian, Lubuskie, Masovian, Podkarpackie and Świętokrzyskie voivodeships.

It is also worth mentioning the Podkarpackie Voivodeship, where this type of accessibility has improved; primarily due to the development of the rail transport network. Apart from changes in the length of railway transport infrastructure, demographic density is also influenced by changes in population, including migration.

Taking into account the research results in this area, the demographic accessibility of rail transport infrastructure improved in the Lubuskie and Podlaskie voivodeships, and remained unchanged in the Lower Silesian and Lubuskie voivodeships. In other voivodeships this indicator worsened.

Demographic and spatial density indicators of rail transport infrastructure can be used to comparatively assess one feature - the length of rail roads per area or per population. The above indicators can be used for a more advanced analysis involving the calculation of the weighted average density indicator Table 3).

***Table 3.*** *Changes of the weighted average density index in 2000-2020.*

| item | | Dolnośląskie | Kujawsko-pomorskie | Lubelskie | Lubuskie | Łódzkie | Małopolskie | Mazowieckie | Opolskie | Podkarpackie | Podlaskie | Pomorskie | Śląskie | Świętokrzyskie | Warminsko-mazurskie | Wielkopolskie | Zachodniopomorskie |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **weighted average density (x100)** | **2000** | 0,72 | 0,69 | 0,51 | 0,79 | 0,51 | 0,50 | 0,40 | 0,82 | 0,48 | 0,39 | 0,66 | 0,92 | 0,59 | 0,70 | 0,’ 4 | 0,62 |
| | **2010** | 0,73 | 0, 64 | 0,43 | 0,79 | 0,47 | 0,49 | 0,40 | 0,83 | 0,53 | 0,45 | 0,60 | 0,85 | 0,59 | 0,65 | 0,64 | 0,62 |
| | **2020** | 0, 56 | 0, 72 | 0, 47 | 0,53 | 0,87 | 0,48 | 0,75 | 0,16 | 0,96 | 0,37 | 0,78 | 0,88 | 0,30 | 0,86 | 0,97 | 0,35 |

***Source:*** *Own analysis based on: Results of transport operations.*

The basic effect of the reduction in the length of rail transport infrastructure is the deterioration of the density of the line center index, which results in the deterioration of access to public collective transport services throughout the country.

This is particularly burdensome for people without access to passenger cars, elderly people and people who cannot use passenger cars for various reasons, e.g., due to age or lack of driving licenses. Regionally, the weighted average indicator significantly deteriorated in the following voivodeships: Kujawsko-Pomorskie, Lubuskie, Opolskie, Świętokrzyskie and Zachodniopomorskie.

## 6. Conclusion

Limiting the length of railway lines in Poland and transport services in Poland for the part of society that does not have individual means of transport is a significant problem in terms of their mobility. This results in communication exclusion of part of the population, deterioration of social cohesion and, consequently, social exclusion.

From the social point of view, transport services ensure territorial cohesion, and by ensuring mobility, they influence the standard of living of citizens, satisfying the natural need for mobility, social satisfaction, and also contribute to reducing the phenomenon of social exclusion. Rail transport is also a key factor in economic development.

Therefore, it is also important to look at the benefits that the development of rail transport infrastructure can bring at the regional level. Its effectiveness promotes the development of the region, thus increasing regional competitive advantage, innovation, the inflow of new investments (e.g.. FDI), but also the maintenance of existing enterprises. Statistics show that there is a tendency in Poland to limit the length of railway lines, although it varies regionally. Its maintenance and development, due to its deficit nature, requires support from the state. This approach is based on the assumption of developing equal access of the general public to public transport, including rail transport.

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