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Prezes Zarządu

Dyrektor Generalny POLREGIO S.A.

DOI: 10.35117/A_ENG_23_04_03

Technical-Economic and Organizational Conditions for the Development of Railway Infrastructure in the Poznań Metropolitan Area with Particular Emphasis on the Needs of the Poznań Metropolitan Railway

Abstract: This article analyzes the network of railway lines located within the Poznań Metropolitan Area (POM) concerning the improvement of service quality provided by rail transport to residents. It is assumed that the optimal solution ensuring proper communication services in the context of increasing road congestion due to rising car traffic is rail transport. At the beginning of the article, a description and evaluation of the layout and operational parameters of the railway lines located within the Poznań Metropolitan Area are presented, with particular emphasis on nine (9) railway lines radiating from the Poznań Railway Junction. The conducted evaluation serves to formulate conclusions aimed at identifying the needs for complementing the existing track network in future financial perspectives for the development of railway infrastructure.

Keywords: Railway infrastructure; Poznań Metropolitan Railway; Poznań Railway Junction

Railway Infrastructure of the Poznań Metropolitan Area

The basic layout of the railway network in the Poznań Metropolitan Area (POM) consists of 9 railway lines radiating from the Poznań Railway Junction (PWK) in all directions (Fig. 1).

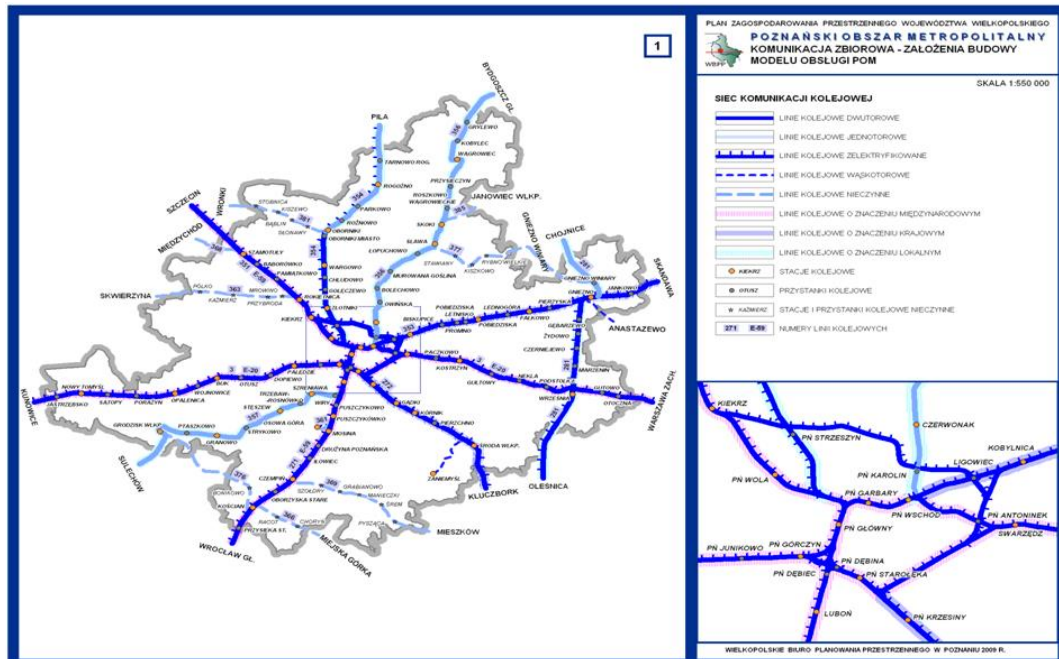
These are:

- To Września, line no. 3 from km 261.313 to km 304.656;
- To Nowy Tomyśl, line no. 3 from km 304.656 to km 362.785;
- To Leszno, line no. 271 from km 94.774 to km 164.455;
- To Wroniek, line no. 351 from km 0.000 to km 52.185;
- To Jarocin, line no. 272 from km 133.574 to km 201.507;
- To Wągrowiec, line no. 356 from km 0.000 to km 52.010;
- To Wolsztyn, line no. 357 from km 38.852 to km 112.182;
- To Gniezno, line no. 353 from km 0.000 to km 47.543;
- To Rogoźno, line no. 354 from km 0.000 to km 43.432.

On the aforementioned railway lines, in accordance with the provisions of the National Railway Program until 2023, the achievement of maximum train speeds in the range of 120-160 km/h is planned:

- 160 km/h on lines no. 3, 271, and 351, except for sections within the city limits;
- 150 km/h on line no. 353;
- 120 km/h on lines no. 356, 357, 272, and 354.

These speeds are optimal for the operation of railways serving the passenger needs of the Agglomeration and, more broadly, the POM by the Poznań Metropolitan Railway (PKM).



1. Railway Network Plan in the Agglomeration Source [12]

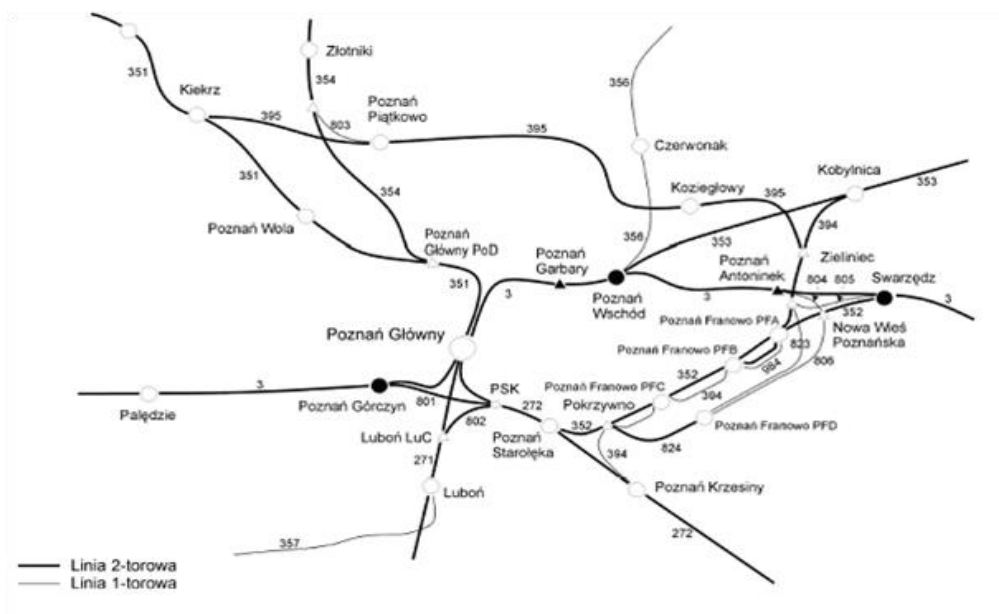
The railway network in the Agglomeration (Fig. 2) is complemented by lines forming the Poznań Freight Bypass and connecting tracks. The Poznań Freight Bypass consists of:

- Line No. 395 Zieliniec – Kiekrz (entire length) of 20.368 km;
- Line No. 352 Swarzędz – Poznań Starołęka (entire length) of 11.662 km;
- Line No. 394 Poznań Krzesiny – Kobylnica (entire length) of 15.979 km;
- Additionally, connecting tracks that supplement the described network.

The main part of the described track system has been or will be modernized, and in the future, after the construction of the planned connecting railway between lines No. 354 and No. 395, it will be possible to utilize them for the operation of the Poznań Circumferential Railway (PKO).

To ensure an optimal railway network layout that meets the needs of the region, institutions interested in improving the quality of communication services for the residents of the Poznań Metropolitan Area indicate the following needs for complementing the railway infrastructure:

- Restoration of railway traffic on Line No. 363 (officially removed from the PKP PLK line list) Rokietnica – Skwierzyna;
- Construction of a new railway line from Poznań Main POD station (Poznań Jeżyce) to Ławica Airport and further to Tarnowo Podgórne [2].



2. Scheme of the Poznań Railway Junction (PWK) [16]

To ensure high-quality communication services, the agglomeration railway system (or metropolitan railway) requires frequent train operations, which necessitates adequate track system capacity. Until 2008, Poznań Main Station was equipped with a mechanical control system dating back to the 1920s, negatively impacting the overall capacity of the junction. Between 2005 and 2009, the Poznań Railway Junction underwent extensive modernization, including the upgrade of railway infrastructure and the adjustment of the track layout. Most importantly, an electronic train control system was introduced. These changes enabled the control of train movements from a single control center, increased capacity, and improved traffic safety. Currently, the track layout and control system allow for the implementation of the basic premises of the metropolitan railway [9]. However, it requires infrastructural expansion in the event of further stages [15].

Within the Poznań Metropolitan Area (POM), there are approximately 70 railway stations and stops, with passenger infrastructure in varying states of technical condition. These station buildings, which have been taken over by municipalities (local government units – JST), are in good condition; however, about 50% of the remaining buildings require extensive renovations. Meanwhile, the platforms at stations and stops located along the modernized lines are being thoroughly upgraded and meet 21st-century standards.

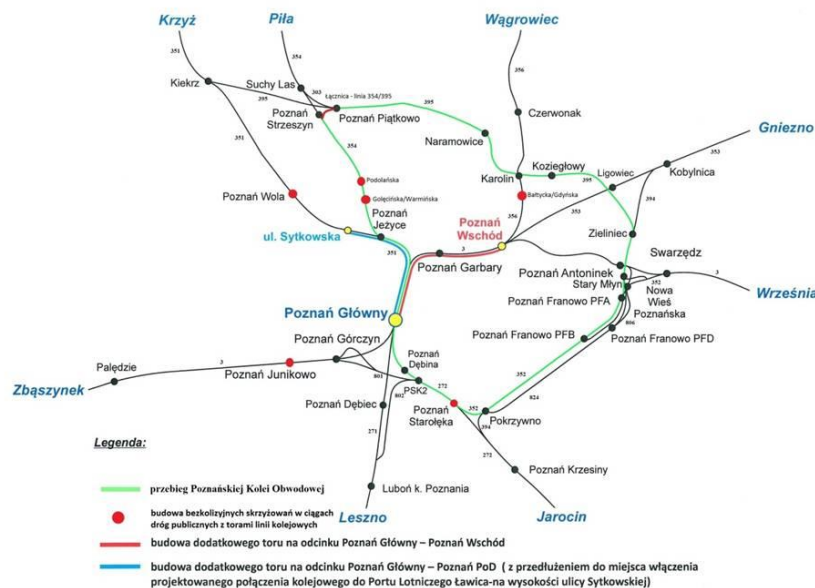
Possibilities and Costs of Increasing the Capacity of the Railway Junction

According to the adopted assumptions, the Poznań Metropolitan Railway (PKM) is intended to transport the inhabitants of the agglomeration along nine railway lines radiating from the Poznań Railway Junction (PWK). According to the plans of PKP PLK S.A., all these lines, essential for the launch of the first stage of PKM, will achieve a speed standard in the range of 120-160 km/h by the end of the current EU perspective, which is optimal for agglomeration traffic [11]. PKM is characterized primarily by a higher frequency of connections compared to the regional railways serving the entire Greater Poland. This frequency should increase by approximately 50% compared to the current level, and during peak hours in the Agglomeration area, it should not be less frequent than every 30 minutes. Furthermore, schedule regularity is desirable, i.e., ensuring equal intervals between trains and their departures at the same minutes of each hour. Such an assumption directly affects the capacity of PWK, including Poznań Main Station [14].

The capacity of PWK was sufficient for the launch of the first stage of PKM. However, the development of PKM will require investments in both the track layout and the train control system [10]. Priority should be given to investments on both routes leading to the northern approaches of Poznań Main Station (Fig. 3). Depending on the development of PKM, the following should also be anticipated in further stages [14]:

- Construction of selected crossovers;
- Increasing the number of tracks between the PSk2 depot (Poznań Dębina) and Poznań Starołęka station – this investment could also be realized in the case of constructing high-speed railways in Poland;
- Construction of overpasses at railway and public road intersections, according to state assumptions [13], co-financed with public road managers.

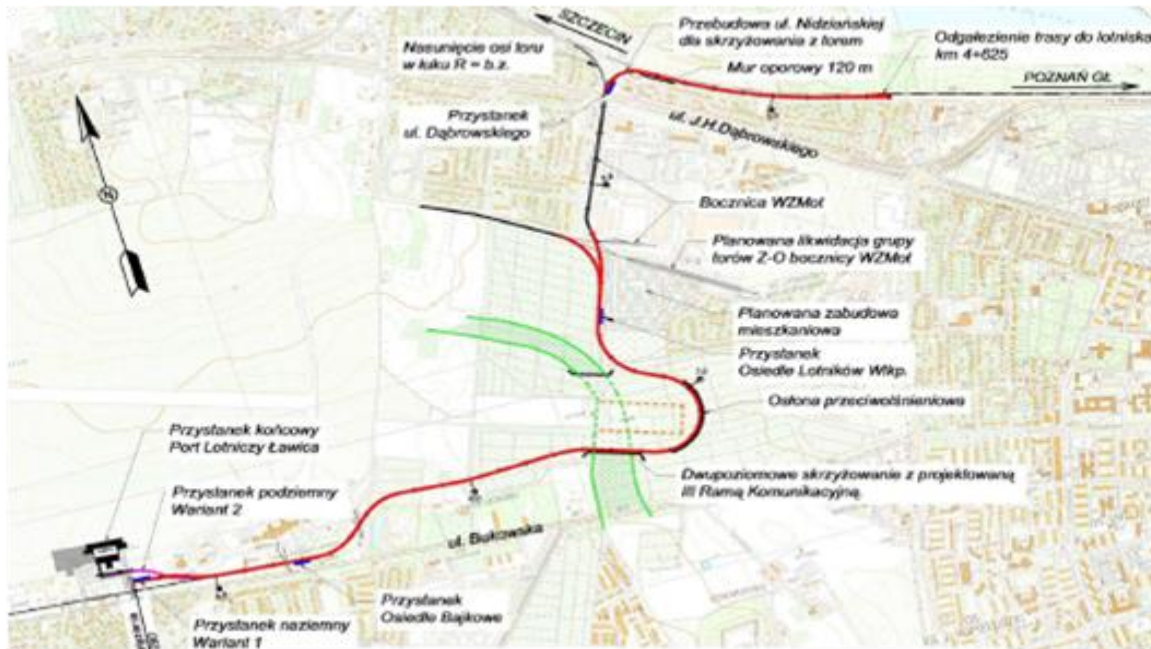
As part of PKM, planned for implementation in the second or third stage, is the Poznań Circumferential Railway (PKO). This railway is intended to provide passenger services to the outer part of the city, efficiently and quickly connecting the northern and eastern areas with the center. The realization of this initiative requires the adaptation of the existing city freight bypass and the construction of the Piątkowo – Strzeszyn connecting track (Fig. 3). Adapting the bypass to passenger needs requires improving its technical parameters, which is being carried out recently, as well as building new railway stops and their spatial integration with city transport stops. The frequency of PKO operations should be no less frequent than every 20 minutes [7].



3. Selected Investments in the Poznań Railway Junction Area

Source: Own elaboration based on the map of PKP PLK S.A. Regional Branch in Poznań.

Another significant investment from the perspective of the Agglomeration's development is the connection of the Tarnowo Podgórne municipality to the City via a railway line. This suburban municipality is a vibrant economic center with high transport potential and is one of the two (out of 18) municipalities in the County lacking access to the railway. It is noteworthy that approximately 26,000 people reside in its area, while there are around 30,000 [3] jobs located there. This line would simultaneously serve Poznań-Ławica Airport (Fig. 4), transporting passengers to the center of Poznań City at Poznań Main Station in approximately 15 minutes [1]. The realization of this project will also significantly enhance the competitiveness of Poznań Airport.



4. Railway connection with Ławica airport [8].

The aforementioned projects, compiled in Table 1, have a significant impact on the overall capacity of the PWK. However, their implementation will enable an improvement in the quality of movement throughout the entire Agglomeration, limit the adverse effects of the suburbanization process, and have a substantial impact on the reurbanization process of the City. At the same time, the estimated cost of these investments, including the need to build overpasses to streamline car traffic, is several times lower than the necessary investments in the road network. In the long-term perspective, the investment costs further justify investing in the railway network, whose expansion costs (approximately PLN 5 billion) are about 10 times lower than the estimated costs of investments in roads and car parks.

Table 1. Necessary Investments in the PWK Area (Poznań Railway Junction)

No.	INVESTMENT	COST (MILLION PLN)
1.	Modernization of Poznań's freight ring road and its adaptation for passenger ring traffic in order to launch PKO	600
2.	Construction of the third track on the Poznań Główny - Poznań PoD (Poznań Jeżyce) section.	100
3.	Construction of the railway connector for line no. 354 Poznań - Piła with line no. 395 Zieliniec – Kiekrz: Piątkowo-Strzeszyn connector.	50
4.	Construction of the third track on the Poznań Główny – Poznań Wschód section.	500 - 800
5.	Construction of six grade-separated intersections between public road sections and railway lines in the Poznań city area.	300
6.	Construction of a new railway line connecting Poznań Główny station with Ławica Airport and further with Tarnów Podgórny.	400
Total:		1.950-2.250

Source: The Concept of the Directions of Spatial Development of the Poznań Metropolis, CBM UAM

Finally, two additional aspects should be noted. The Poznań Starołęka station serves as an interchange point for passenger train routes and freight trains bypassing the city center. Plans to route up to three PKM lines through this station, as well as the prospect of constructing high-speed railway lines in the vicinity of this station, indicate the necessity to

anticipate the expansion of the Poznań Dębina (PSk-2) – Poznań Starołęka section to four tracks.

On the single-track lines Poznań – Wągrowiec and Poznań – Grodzisk Wielkopolski – Wolsztyn, the location of passing loops significantly affects the ability to maintain the schedule and shape the timetable at Poznań Główny station. Upon adopting the concept for the subsequent stages of the PKM, it is therefore necessary to optimize the locations of passing loops (add the missing ones) so that the future metropolitan railway timetable can maintain an appropriate frequency. A similar, though smaller in scale, issue concerns double-track lines where a faster train may catch up to a metropolitan train, requiring the provision of a passing loop for the smooth passage of the faster train. In this situation as well, optimizing the locations of passing loops is recommended.

Another problem that occurs incidentally but significantly degrades travel comfort is malfunctions of railway traffic control devices at Poznań Główny station. For example, in 2020, there were three device failures that caused train delays at Poznań Główny station and disruptions on adjacent railway sections.

The high priority of this issue is evidenced by actions taken by the infrastructure ministry and the railway infrastructure manager. This is reflected in the response from the Minister of Infrastructure to inquiry no. 16393 by MP Katarzyna Ueberhan, which included a description of the underlying problems and the preventive measures implemented.

In response to the aforementioned inquiry, information was provided indicating that to ensure high availability and operational efficiency of the SRK computer devices, a pilot central agreement titled “Support for the Maintenance Process of Computer Devices Manufactured by Thales Polska Sp. z o.o.” was concluded in 2018. Under this agreement, the contractor provides post-warranty service services in nine Railway Line Facilities (including the facility in Poznań), particularly in the removal of defects and failures in internal computer-based devices (including software areas), event analysis, provision of spare parts, and specialized inspections. The agreement is ongoing. A detailed regulation for handling LCS Poznań devices in emergency situations has also been developed.

Summary

The information presented in the article regarding the development of railway infrastructure located in the Poznań Metropolitan Area confirms that the efforts of the institutions responsible for the railway system's operation in Greater Poland have laid the foundations for the creation and development of the Poznań Metropolitan Railway, aimed at improving the quality of communication services.

Furthermore, it is worth highlighting the government's commitment to infrastructure development in Greater Poland, as evidenced by the signing of agreements on January 27, 2023, concerning the implementation of Greater Poland projects under the Railway Plus Program for Supplementing Local and Regional Railway Infrastructure until 2028. As a result, passenger trains will once again reach Śrem, Międzychód, Gostyń, and Czarnków. The fifth project involves the construction of an entirely new railway line to Turku.

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