

# Research on Punctuality of Public Transport Benchmarking the Polish National Railways

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## Abstract

This article seeks to analyze the reliability of the Polish State Railways (PKP) as the benchmark railway promptness and timekeeping. Railways punctuality is crucial in its given capacity of colossal mobility day-by-day. The accuracy in time keeping railways results in increased productivity, better academic performance and improved wellness. This study concludes the Polish National Railways promptness and timekeeping is about 90% and below par. To benchmark railway promptness, respondent observations are tabulated in tables and charts to show analysis by statistical measure. More importantly, the article outlines opportunities for improvement in the procedures that impact the punctuality of rail public transportation.

## Article Highlight

- Rail delays across routes studied in this duration, did not pose major inconvenience to travellers.
- Some reasons of delays are uncategorized, making it difficult to analyze and improve.
- Comparative studies on railway promptness by UTK statistics, find the average punctuality of trains at 91.64%.

## 1. Introduction

Mobility is a constructive measure for the advancement of humanity. On the overall, the automobile and other forms of individual transport comprise a relatively small portion of the community mode of travel. A larger part of the society living in the far-flung villages and even at the metropolis, avail public transport, such as bus, tram, metro or train. Significantly, the continuous expansion and modernization of public transport allows for fast and convenient travel. By benchmarking on the PKP carriers, this article discourses; what influences railway promptness and to what extent are these effective.

Punctuality of public transport is the phenomenon, whether trains run according to the scheduled timetable. The ability to make such services collectively available at regular intervals and at stations along a specific line or network had been examined [1]. Subsequently, these findings had been construed alongside the results of numerous similar literatures such as; "Analysis of the punctuality of passenger trains in 2018"[2].

With the goal to raise public transportation standards, Government constituted the "Program for the construction and launch of high-speed rail transport in Poland", which established an Inter-ministerial Team for High-Speed Railways [3]. To set the pace and direction of the outcomes, the formulation of strategic options had been conscripted in a manuscript "Transport Development Strategy until 2020 (with a perspective until 2030)[4].

Issues related to the business environment, mostly technical and organizational; are explored in the book "Organization of railway traffic" by Polish Scientific Publishers PWN publishing house [5]. Alternatively, an enumeration of research methods, analysis and observations of traveller mobility by rail are found in the study "Passenger rail transport in metropolitan regions in Poland and multimodal solutions in everyday is commuting,"

authored by Karol W. Kowalczyk [6]. A 2023 study on various modes of transport, detailing on railway reliability in terms of freight movement, is the work of Wyzsza & Gospodarki in the book "Economic and organizational aspects of transport"[7]. The importance of punctuality had been highlighted in the report of the Office of Rail Transport "Assessment of the functioning of the rail transport market and the state of rail traffic safety in 2012"; specifically over the EURO 2012 tournament, wherein trains had been moving travellers to competitions, if not to airport terminals [8].

Public transport reliability is also the subject of foreign articles. These include the "Punctuality Index for Bus Operation" by Noorfakhriah Yaakub and Madzlan Napiah; publishers of the World Academy of Science, Engineering and Technology (WASET), where the work illustrates methods of punctuality testing for public bus transport [9]. An identical reiteration surmised in the article "Bus punctuality - towards a structure that can deliver" which underscored pathways for the development of public transport [10]. Articulated in the "Aspects of improving punctuality from data to decision in railway maintenance" by Birre Nyström; a summary of issues related to the punctuality of railways in an enumeration to derive various methodology of reporting the phenomenon. Improvement opportunities for collective rail transport promptness are further situated in this report [11]. The study of railway reliability was also included in the works: "Influencing factors on train punctuality: results from some Norwegian studies" by N. Olsson; and "Investigating the effect of weather on punctuality of Norwegian railways: a case study of the Nordland Line" by Zakeri & Olsson [12, 13]. The same phenomenon had been addressed in the work, "Analyzing factors contributing to real-time train arrival delays using seemingly unrelated regression models" written by Tiong, Ma & Palmqvist [14-16].

Taking into account the above assumptions, the paper analyzes the punctuality of public transport on the example of Polish national railroads.

## 2. Characteristics of Polish National Railways

Polish State Railways is a joint-stock company, the sole shareholder of which is the State Treasury, represented by the Ministry of Infrastructure. The company was established as a result of commercialization of the state-owned company Polskie Koleje Państwowe. PKP supervises a group of companies under the PKP Group; with the goal of ensuring high-quality transport and logistics services for passengers and goods.

The task of PKP is to broaden the reach of rail transport in Poland, while ensuring high standards of transport services. To this end, the Company is modernizing the railway infrastructure and adapting the needs of all passenger groups [17].

In 2001, the consortium PKP Group had been established for purpose of isolating the rail transport activity from the management of railway lines and to create entities that can provide services idependently. The companies belonging to the PKP group operate on the railway, energy and teleinformation markets: Sp. z o.o., Xcity Investment, CS Natura Tour and PKP TELKOL. The PKP Group altogether employs about 70 thousand workers, becoming the second largest employer in Poland. The labour force is represented by specialists from the transport, ICT, energy and real estate sectors [17].

## 3. Punctuality of Trains

The Railway Transport Office (UTK) publishes website reports on the punctuality of passenger transport, including comparatives on the change in punctuality levels. The tables contain all carriers; names or numbers which change in accordance to the restructuring of the railway companies. The reports do not list Railway Lines which are part of the PKP Inter-city company (Table 1) [2].

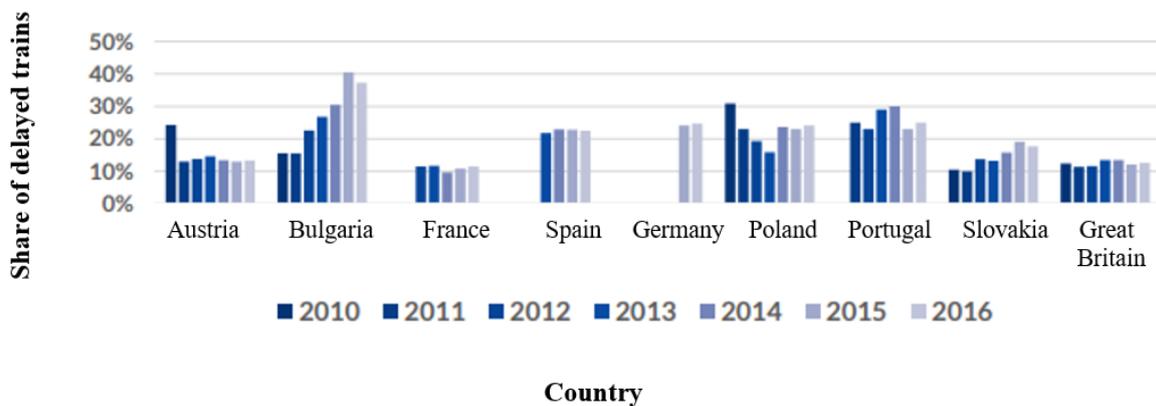
For the Intercity component, the annual punctuality recognized: 80.85% in 2015, 76.74% in 2016, 73.08% in 2017, and 70.48% in 2018. Punctuality worsened each year. The fact that TLK trains (Your Railway Lines) are also included in the punctuality level of the inter-city carrier, the actual level of delays might differ slightly. The punctuality of the Polregio carrier (formerly Przewozy Regionalne) is presented in this way: 92.34% in 2015, 91.36% in 2016, 90.01% in 2017, and 88.6% in 2018. This is a downward trend. Although the level of punctuality slumps year-on-year, the measure on the basis of observations stated in the tables, conclude the Polregio trains are more punctual than the intercity trains. The best punctuality over the period covered identified PKP SKM in the Tri-City, and the worst promptness is the PKP Intercity.

The punctuality results in Poland for the recent years do not differ significantly from the results of other countries. The data in the following is based on reports from IRG-Rail, a group of European countries that aim to create a common and sustainable rail market. The charts (Fig. 1) show that the problem of the punctuality of trains applies not only to Poland, but also to other countries [18].

**Table 1** The level of punctuality of carriers in 2015-2018 [2]

Carrier Name / Year	2015 [%]	2016 [%]	2017 [%]	2018 [%]	Average [%]
PKP Intercity	80.85	76.74	73.08	70.48	<b>75.29</b>
Przewozy Regionalne - Polregio	92.34	91.36	90.01	88.60	<b>90.58</b>
Masovian Railways - KM	89.33	91.14	91.86	88.31	<b>90.16</b>
PKP SKM in the Tri-Csity	99.20	98.61	98.06	97.97	<b>98.46</b>
Fast City Railway in Warsaw	94.42	95.03	94.21	91.16	<b>93.70</b>
Warsaw Commuter Railway	98.94	99.22	99.58	99.46	<b>99.30</b>
Lower Silesian Railways	90.81	89.87	86.63	84.59	<b>87.97</b>
Silesian Railways	89.59	88.31	86.33	88.91	<b>88.28</b>
Greater Poland Railways	93.46	89.74	91.36	87.89	<b>90.61</b>
Arriva RP	92.23	92.75	93.01	93.27	<b>92.81</b>
UBB GMBH	98.69	98.97	98.55	97.59	<b>98.45</b>
The Łódź Agglomeration Railway	97.12	96.23	95.75	95.30	<b>96.10</b>
Lesser Poland Railways	98.81	95.12	85.02	79.38	<b>89.58</b>
<b>Average:</b>	<b>93.52</b>	<b>92.54</b>	<b>91.03</b>	<b>89.45</b>	<b>91.64</b>

When comparing data from reports of the Office of Rail Transport in previous years, against the results obtained from the conducted punctuality test; the methodology applied to obtain both records is the same. The delay of trains included those that arrived 5 minutes late. However, the study at work was based on ten different routes for each carrier, and UTK in its reports includes all possible carrier relationships.

**Fig. 1** Share of delayed trains for long-distance trains [18]

The Railway Market in the first quarter of 2019 finds the punctuality of passenger trains at 93.06%; and in the first quarter of 2020 at 94.68%. An escalating level of punctuality can be observed in January, at 93.95%; in February at 94.28% and in March at 95.94%. The highest level of punctuality was achieved in March, due to the coronavirus epidemic, where the first steps to prevent the spread of the virus began in the middle of the month. The increase in punctuality is caused by the reduced number of passenger trains. Less interest among travelers and increased capacity of railway lines contributed to the increase in punctuality. More trains will be restored in the coming months, so the level of punctuality is likely to deteriorate [19].

## 4. Research

### 4.1 Purpose and Scope of Research

The aim of the research is to analyze the reliability of public transport by rail, benchmarking on the services of PKP. Nowadays, the phenomenon of mobility has become the norm, becoming more frequent with the many different modes; and easy access to individual transport. Punctuality is one of the factors that determine the mode of transport; and rail has been most popular for many years. The scope of the research includes observing whether

trains run according to the timetable, calculating the level of punctuality, travelers' opinions and optimization methods to increase punctuality.

## 4.2 Research Object

The object of research is the punctuality of public transport. The data included the railway carriers "Intercity", "Polregio" and "Your Railway Lines".

PKP Intercity carrier provides long-distance passenger services on rail. The carrier offering includes express and express passenger transport, as well as sleeping and berth carriages. Supported connections include over 400 localities in Poland, but also international and occasional sections [20].

Polregio provides services in the field of passenger rail transport and is the largest carrier in Poland. Polregio deals with the operation of passenger and fast trains, organizes transport related to mass events, colonies and trains on individual orders. The scope of activities covers the entire territory of Poland. Until January 23, 2020, the company was called Przewozy Regionalne [21].

"Your Railway Lines" include long-distance connections and these are trains launched by the PKP Intercity Company. The carrier offers inter-connections across the metropolitan region and transport between smaller cities, ensuring low ticket prices and high comfort. Its offer includes day and night fast connections, as well as trains running beyond the eastern border [22].

## 4.3 Research Methodology

In order to standardize the testing of train punctuality, the International Union of Railways (UIC) has defined test methods which, in turn, do not impose a common method on carriers, but only provide rules that these companies use to analyze international rail traffic [23].

The Regulation of the Minister of Infrastructure and Construction of April 7, 2017 on the provision of railway infrastructure includes a provision that defines the punctuality limit in domestic transport - 5 minutes after the timetable is not taken as a delay. This set standard is used by PKP in the measure of punctuality. Until 2018, UTK treated trains with a delay not exceeding 5 minutes as punctual. From 2019, the UTK method was modified and assumed that trains delayed from 6 minutes upwards would be considered delayed, while others, below 5:59 minutes, arrived on time. The same industry standard are also applied in countries such as Germany, Belgium or France [24].

The methodology in the investigation of the punctuality of public transport is sheer observation. The observation consisted of two parts. In the first of them, the punctuality of trains selected for the study of three domestic carriers was observed: Your Railways, Intercity, Polregio, and in particular the comparison of their timetables with the actual time of the train's journey from the starting station to the final station. These observations were made in the period from the beginning of January 2019 to the end of February 2020 on the PKP website, and the observations and data are included in the table in the paper. The second part of the research consisted in a thorough analysis and summary of observations in the form of graphs and conclusions that were included in the work.

The second method of testing punctuality, based on the research technique, was the survey entitled: "Testing the punctuality of public transport on the example of PKP" addressed to the general public. According to Tadeusz Plich's definition, a survey is usually a standardized questionnaire, which is filled in by the respondent by answering open or closed questions, and can do it both in the presence and without the presence of the interviewer [25].

An electronic questionnaire was developed and then used to collect information. It contained 12 questions. In the questionnaire, in questions 1, 2, 4, 6, 8, 9, 10, 11, a closed cafeteria was used - because ready-made sets of answers were prepared, beyond which it was impossible to go out, the respondent had to choose from those given, and a semi-open cafeteria, questions number 3, 7, 12 - examples of answers, containing a point marked "other", which allowed for a different answer. The last question of the questionnaire 13, the question is open-ended. Data collection lasted from November 2019 to January 2020. A preliminary study was conducted, which allowed adjusting the content of the questions so that they were understandable for the respondents and that the obtained results turned out to be useful and reliable. The survey can be found in the Appendix.

## 4.4 Analysis of Research Results

The paper presents data on the delays of passenger trains of three selected carriers (Table 2): Intercity (IC), Polregio (PREG), Twój Linie Kolejowe (TLK). The survey was conducted in 2019.

**Table 2** Routes on which the study was performed

Ordinary number	Starting station of the train - Finishing station of the train	Time of departure and arrival	Carrier
1	Jelenia Góra - Przemyśl Główny	10:20 - 19:25	IC
2	Szczecin Główny - Kraków Główny	06:10 - 14:16	IC
3	Zielona Góra - Rzeszów Główny	08:39 - 16:13	IC
4	Leszno - Kraków Główny	07:06 - 11:58	IC
5	Leszno - Tarnów	07:06 - 13:25	IC
6	Wrocław Główny - Olsztyn Główny	08:31 - 14:57	IC
7	Szczecin Główny - Warszawa Centralna	06:00 - 13:15	IC
8	Piła Główna - Gliwice	8:49 - 15:15	IC
9	Katowice - Kołobrzeg	06:44 - 16:05	IC
10	Lublin Główny - Poznań Główny	17:15 - 00:03	IC
11	Piła Główna - Olsztyn Główny	14:55 - 20:05	PREG
12	Białogard - Szczecin Główny	04:47 - 06:52	PREG
13	Gdynia Główna - Malbork	14:49 - 16:05	PREG
14	Wałcz - Szczecin Główny	16:02 - 18:39	PREG
15	Katowice - Rzeszów Główny	05:24 - 10:02	PREG
16	Racibórz - Wrocław Główny	06:01 - 08:47	PREG
17	Międzyzylesie - Zielona Góra	12:26 - 17:30	PREG
18	Siedlce - Hajnówka	17:45 - 19:56	PREG
19	Stalowa Wola Rozwadów - Lublin Główny	05:31 - 07:20	PREG
20	Ełk - Białystok	05:38 - 07:26	PREG
21	Gdańsk Główny - Warszawa Centralna	05:22 - 09:05	TLK
22	Piła Główna - Warszawa Centralna	06:09 - 11:25	TLK
23	Gorzów Wielkopolski - Lublin	06:49 - 17:11	TLK
24	Bydgoszcz Główna - Opole Główne	05:02 - 10:35	TLK
25	Zielona Góra - Olsztyn Główny	12:49 - 18:25	TLK
26	Zielona Góra - Wrocław Główny	05:06 - 08:45	TLK
27	Kutno - Bydgoszcz Główna	10:05 - 12:08	TLK
28	Katowice - Gdynia Główna	09:16 - 18:39	TLK
29	Bydgoszcz Główna - Zakopane	06:13 - 18:10	TLK
30	Krynica-Zdrój - Gdynia Główna	11:02 - 23:49	TLK

The punctuality of the tested trains for each relation is presented in Table 3, in which particular relations were distinguished by month. In the analyzed period, the Intercity carrier recorded the lowest punctuality on the Jelenia Góra - Przemyśl Główny route - 79.45%, Polregio on the Katowice - Rzeszów Główny route - 95.62%, and your Railway Lines - 90.41% on the Piła Główna - Warsaw Central route. Observations show that frequent rolling stock failures are the main cause of delays on these lines.

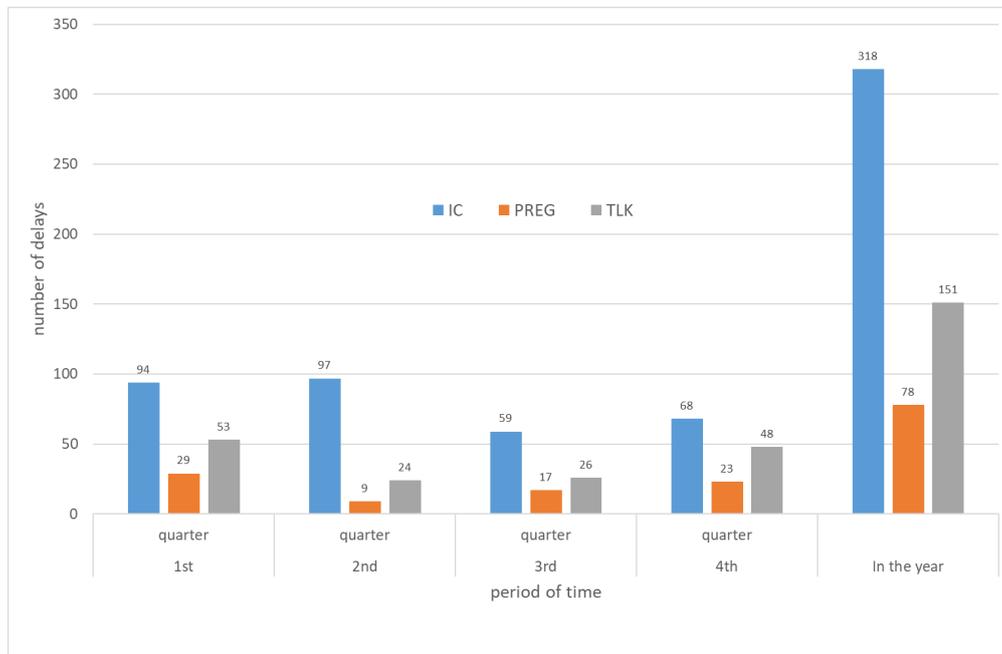
**Table 3** Number of delays with breakdowns by month in the analyzed period

Ordinary number	The relationship	Carrier	Punctuality of trains [%]												Average
			January	February	March	April	May	June	July	August	September	October	November	December	
1	Jelenia Góra - Przemysł Główny	IC	100.00	99.73	95.89	97.26	96.71	97.53	97.26	98.90	98.08	99.18	99.73	99.18	98,29
2	Szczecin Główny - Kraków Główny	IC	98.90	99.18	95.62	97.53	96.99	97.53	97.81	100.00	98.90	99.73	99.18	99.73	98,42
3	Zielona Góra - Rzeszów Główny	IC	100.00	99.18	98.90	98.08	100.00	99.73	99.73	99.18	99.73	99.45	99.45	96.71	99,18
4	Leszno - Kraków Główny	IC	99.18	99.45	99.73	99.45	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.08	99,66
5	Leszno - Tarnów	IC	99.18	100.00	99.45	98.36	99.73	99.73	99.45	100.00	100.00	100.00	97.81	99.45	99,43
6	Wrocław Główny - Olsztyn Główny	IC	98.90	98.63	99.45	99.18	99.18	99.18	99.73	99.45	99.73	100.00	99.45	99.73	99,38
7	Szczecin Główny - Warszawa Centralna	IC	97.26	99.18	100.00	99.18	99.18	99.73	99.18	100.00	98.63	99.18	98.63	98.63	99,06
8	Piła Główna - Gliwice	IC	99.73	99.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99,95
9	Katowice - Kołobrzeg	IC	100.00	99.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99,98
10	Lublin Główny - Poznań Główny	IC	99.73	97.53	100.00	100.00	99.18	100.00	98.36	99.73	100.00	98.90	99.18	100.00	99,38
11	Piła Główna - Olsztyn Główny	PREG	100.00	99.73	100.00	100.00	99.73	100.00	99.73	100.00	99.73	99.45	100.00	100.00	99,86
12	Białogard - Szczecin Główny	PREG	100.00	99.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.73	99,95
13	Gdynia Główna - Malbork	PREG	100.00	99.73	100.00	100.00	100.00	100.00	100.00	99.73	99.73	100.00	100.00	99.73	99,91
14	Wałcz - Szczecin Główny	PREG	99.73	99.73	100.00	99.73	100.00	99.45	100.00	99.73	100.00	99.73	100.00	99.45	99,79
15	Katowice - Rzeszów Główny	PREG	100.00	98.90	98.90	100.00	100.00	99.45	99.73	100.00	99.45	99.73	99.45	100.00	99,63
16	Racibórz - Wrocław Główny	PREG	99.73	99.73	100.00	100.00	100.00	100.00	100.00	100.00	99.45	100.00	100.00	99.73	99,89
17	Międzyzlesie - Zielona Góra	PREG	99.73	99.18	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.45	99,86
18	Siedlce - Hajnówka	PREG	99.45	99.73	100.00	99.18	100.00	100.00	100.00	99.45	100.00	99.18	100.00	99.45	99,70
19	Stalowa Wola Rozwadów - Lublin Główny	PREG	99.18	99.73	100.00	100.00	100.00	100.00	99.73	99.18	99.73	99.18	100.00	99.45	99,68
20	Elk - Białystok	PREG	99.73	99.45	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99,93
21	Gdańsk Główny - Warszawa Centralna	TLK	99.73	99.18	99.73	100.00	100.00	100.00	100.00	99.45	99.45	99.18	99.73	99.73	99,68
22	Piła Główna - Warszawa Centralna	TLK	99.45	99.73	98.90	99.45	99.73	99.73	99.73	98.63	98.63	98.90	98.90	98.63	99,20
23	Gorzów Wielkopolski - Lublin	TLK	100.00	99.18	98.90	99.18	100.00	100.00	100.00	100.00	100.00	100.00	100.00	97.53	99,57
24	Bydgoszcz Główna - Opole Główne	TLK	99.45	98.90	99.73	99.73	99.73	98.90	99.73	100.00	100.00	99.73	99.18	99.45	99,54
25	Zielona Góra - Olsztyn Główny	TLK	99.73	99.18	99.45	99.73	99.73	99.45	100.00	99.73	99.45	99.18	99.18	100.00	99,57
26	Zielona Góra - Wrocław Główny	TLK	99.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99,98
27	Kutno - Bydgoszcz Główna	TLK	100.00	99.18	99.18	99.18	98.90	100.00	100.00	100.00	98.63	100.00	100.00	99.45	99,54
28	Katowice - Gdynia Główna	TLK	100.00	99.45	100.00	100.00	100.00	100.00	100.00	100.00	99.73	99.45	99.45	99.73	99,82
29	Bydgoszcz Główna - Zakopane	TLK	99.73	99.18	100.00	100.00	100.00	100.00	100.00	100.00	99.73	100.00	100.00	99.45	99,84
30	Krynica-Zdrój - Gdynia Główna	TLK	99.45	98.36	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99,82

The delays are presented in Table 4 and Figure 2, where the delays in individual quarters and in the annual scale for ten selected relationships of each carrier are analyzed. They show that the most delays were recorded in the first quarter of 2019 for all carriers, and the least in the third quarter. Table 5 lists the same delays as the number of minutes that define the delay time. The reason for such results may be reasons related to the implementation of the investment, i.e. renovation of stations. Moreover, during the winter period, control devices fail frequently, and bad weather conditions also occur.

**Table 4** The number of delays of the surveyed carriers in individual quarters of 2019

	1st quarter	2nd quarter	3rd quarter	4th quarter	In the year
<b>IC</b>	94	97	59	68	318
<b>PREG</b>	29	9	17	23	78
<b>TLK</b>	53	24	26	48	151
<b>Total number of delays</b>	176	130	102	139	547

**Fig. 2** Number of delays in the surveyed carriers**Table 5** Time of delays given in minutes in individual quarters of 2019

	1st quarter [min]	2nd quarter [min]	3rd quarter [min]	4th quarter [min]	In the year [min]
<b>IC</b>	2825	1492	942	1579	6838
<b>PREG</b>	3188	1375	1016	2178	7757
<b>TLK</b>	4136	2355	1537	2648	10676
<b>Total duration of delays [min]</b>	10149	5222	3495	6405	25271

The punctuality of the trains of the analyzed railway undertakings on the studied routes was determined using the punctuality index P [25]:

$$P = \frac{L_p}{L_o} \times 100 \% \quad (1)$$

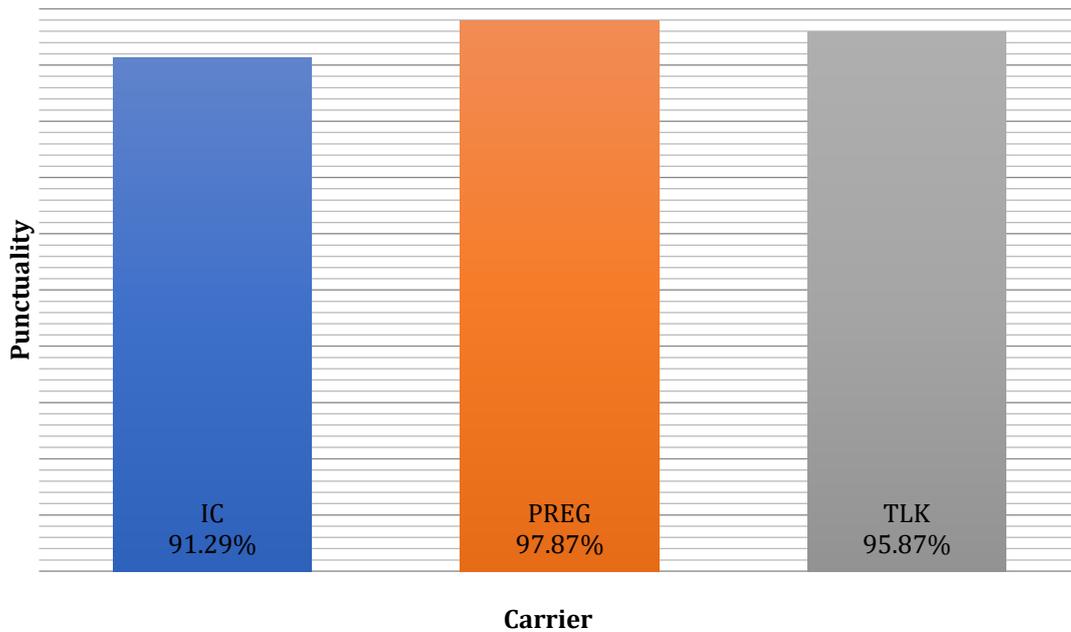
where:

$L_p$  – the number of correct courses, i.e. in accordance with the timetable

$L_o$  – the number of observed journeys, i.e. those provided in the timetable

Intercity trains were the least punctual among the surveyed carriers - punctuality at the level of 91.29%. Then your Railway Lines - 95.87%, and the most punctual Polregio - 97.87%, which had the lowest number of delays (Fig. 3). This may result from the organization of the trip, e.g. placement of passengers, i.e. boarding and

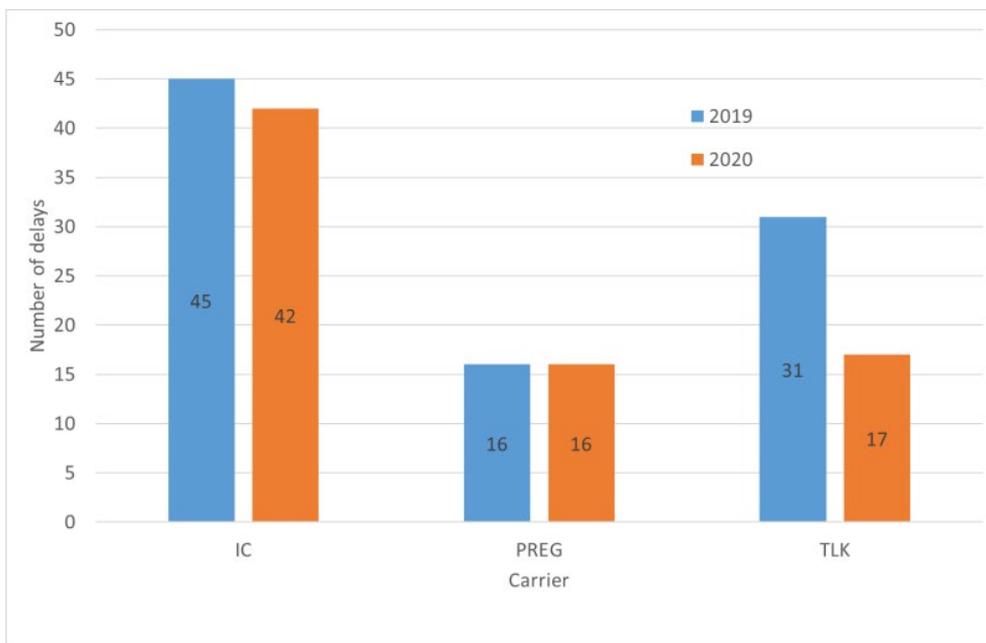
dropping off passengers, incorrect information about the place of train substitution and the popularity of the carrier.



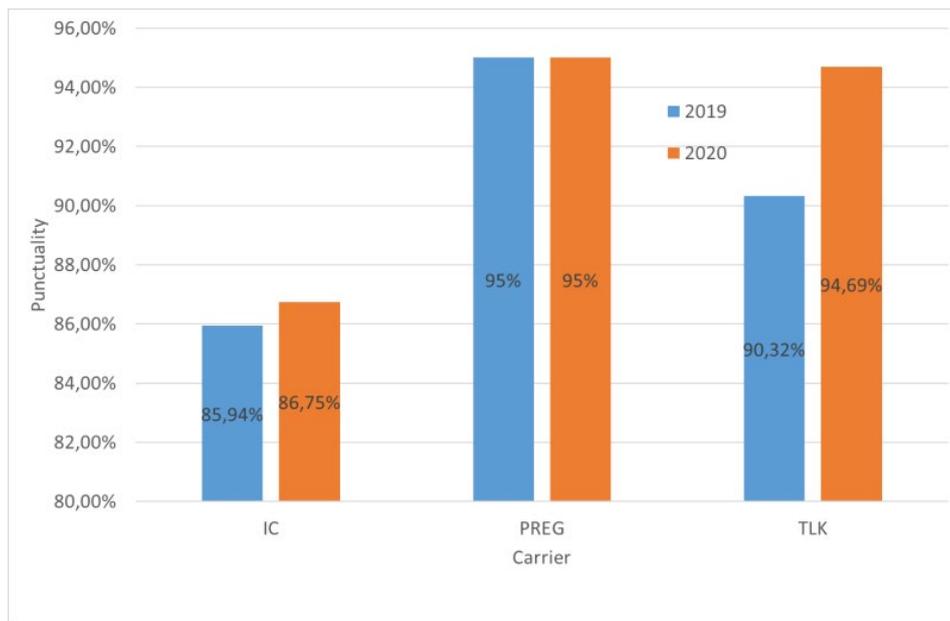
**Fig. 3** Punctuality of trains in 2019

In 2020, the punctuality of the same lines was re-examined within a month. The time period is from January 20, 2020 to February 20, 2020. Again, Polregio can boast the highest punctuality - 95%, then Your Railway Lines - 94.69%, and the intercity trains turned out to be the least punctual - 86.75% (Fig. 4.5). For Intercity, the problem of delays was caused by the continuous implementation of investments, and for other carriers, first of all, they were failures of the rolling stock.

Comparing the corresponding data from 2019 and 2020, it should be noted that the number of delays of the analyzed carriers, except for TLK, did not decrease, and the level of delays in the case of TLK increased, and in other cases it was at a comparable level. The lag issue has not been resolved.



**Fig. 4** Number of delays of the surveyed carriers in the analyzed period in 2019 and 2020



**Fig. 5** Punctuality of trains in the analyzed period in 2019 and 2020

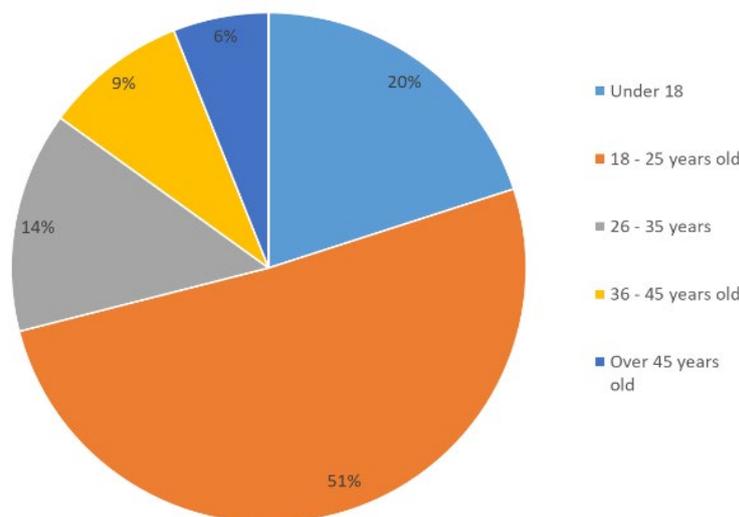
The above chart on the punctuality of railway transport shows discrepancy between the planned and actual arrival of the train, across all lines. Delays are not always carrier related issues. The reasons for delays include: investments in progress, failures of rolling stock, bad weather conditions, and failures of control or supervision devices; traction network, and accidents involving animals, bystanders, theft and devastation of infrastructure elements as well as delays due to the fault of the infrastructure manager.

#### 4.5 Survey Research

A questionnaire survey was conducted to elicit travelers' opinions on the satisfaction using PKP services; particular punctuality. The obtained results had been compared with the observation of the delay phenomenon.

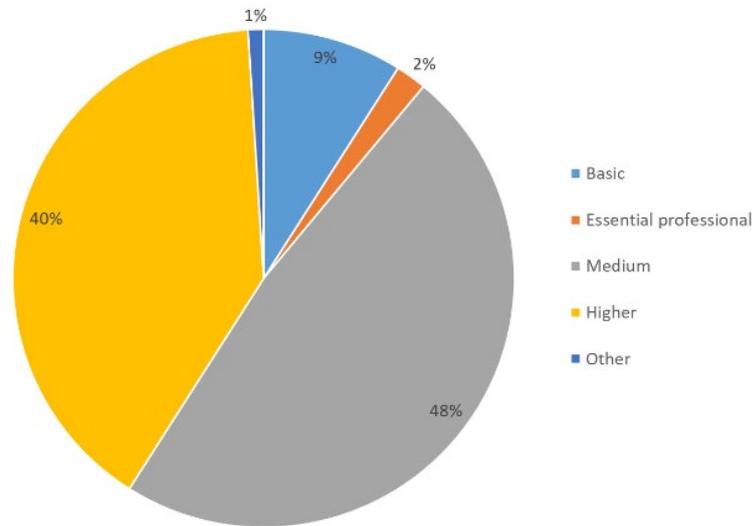
The survey analysis shows that 402 people took part in the survey, of which 54% are men and 46% women. Due to the place of residence, 76% of the respondents live in cities and only 24% live in the countryside.

The age range of the respondents indicates that the majority of respondents are students, accounting for 71%; described as 20% under 18 and 51% age 18-25. Respondents age 25-35 recognize 14%, and 15% of the respondents are middle-aged, 36 and above (see Fig. 6). Large differences between the age groups result from the method of conducting the survey, i.e. through a questionnaire placed on the Internet, hence the largest number of young people in the 18-25 age group.



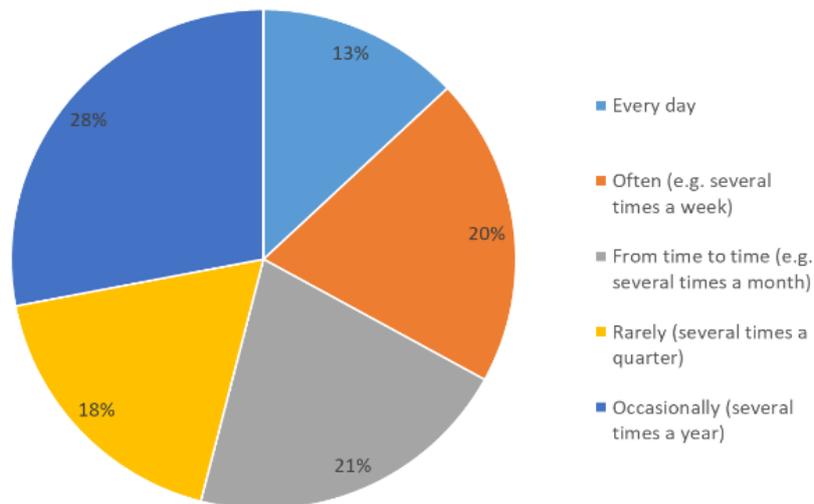
**Fig. 6** Age of respondents

One of the elements of the survey is the education of the respondents. 48% of the respondents have secondary education; people with higher education constitute 40% of the respondents. 9% are people with primary education, 2% with basic education, and 1% uncategorized (Fig. 7). Most of the respondents declare that they have secondary education, which may indicate their further education and it coincides with the age of the respondents.



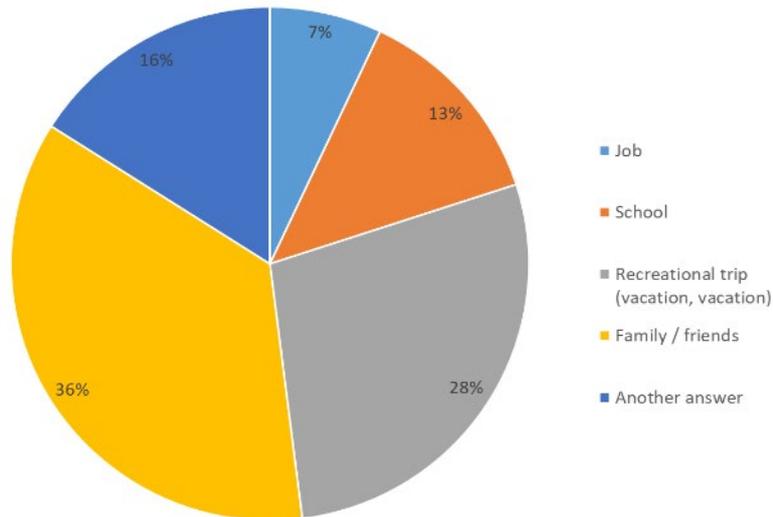
**Fig. 7** Education of respondents

To the question "How often do you travel by PKP?" the respondents most often answered that they travel occasionally, several times a year, 28%, and 21% several times a month. 20% of the respondents travel several times a week, 13% every day (Fig. 8).



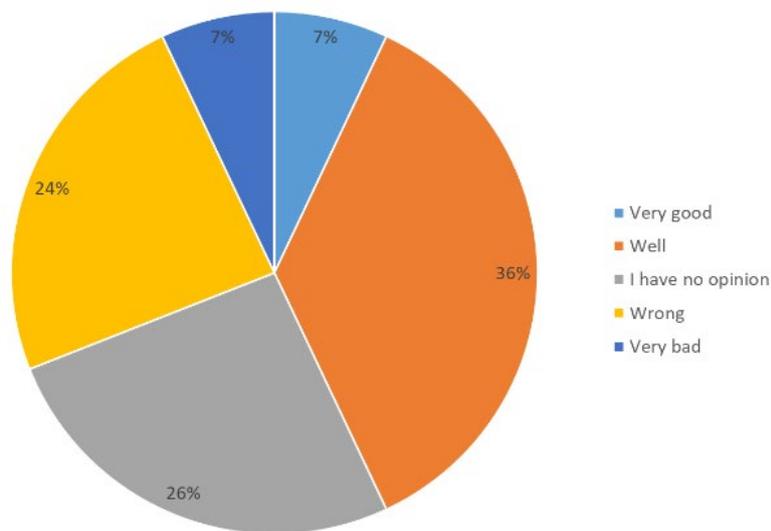
**Fig. 8** Travel frequency

The survey result uncovers traveller’s priority in terms of purpose amongst respondents are visits to family or friends (36%); trips for recreation away from home (28%); and travel to work and school (20%). 16% of travellers are on educational trips, shopping, hobbies, lack of access to another means of transport at a given moment or a journey without destination (Fig. 9). The results coincide with the survey conducted by the Office of Rail Transport, where the most frequent answers to the question about the purpose of the trip were work and school [26].



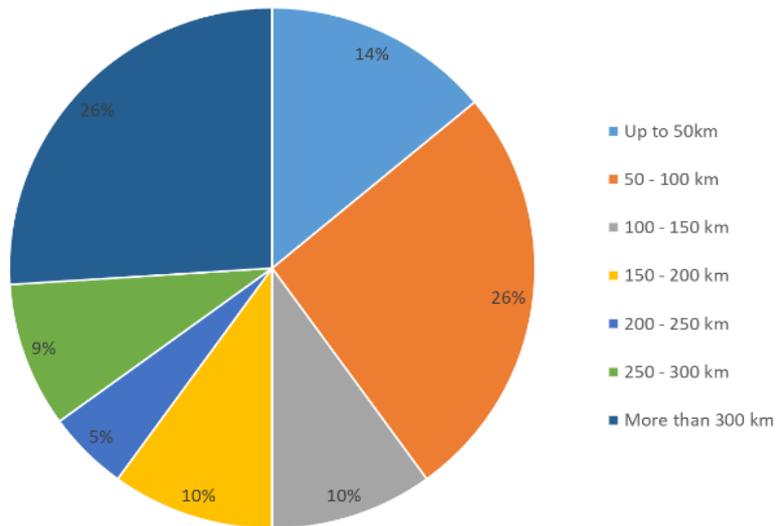
**Fig. 9** The main destination of the PKP journey

According to the respondents, the punctuality of collective rail transport is on average: 43% assess the punctuality as very good and good. 27% rate it badly and very badly. As many as 30% of the respondents did not express opinion, which is likely due to the fact that these people do not pay much attention to the punctuality of trains or rarely use PKP services (Fig. 10).



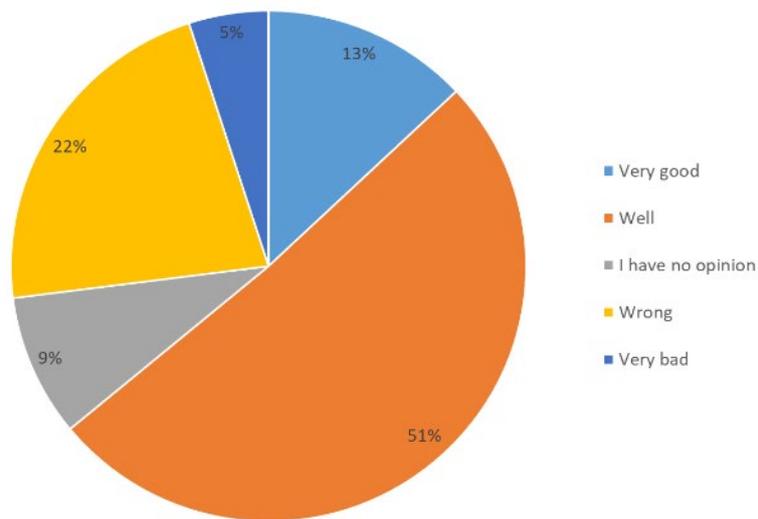
**Fig. 10** Assessment of punctuality of collective rail transport

40% of the respondents cover short distances, up to 100 km. The next group is those who travel far, over 300 km - 24%. The average distances of journeys are covered by 32% of travelers (Fig. 11).



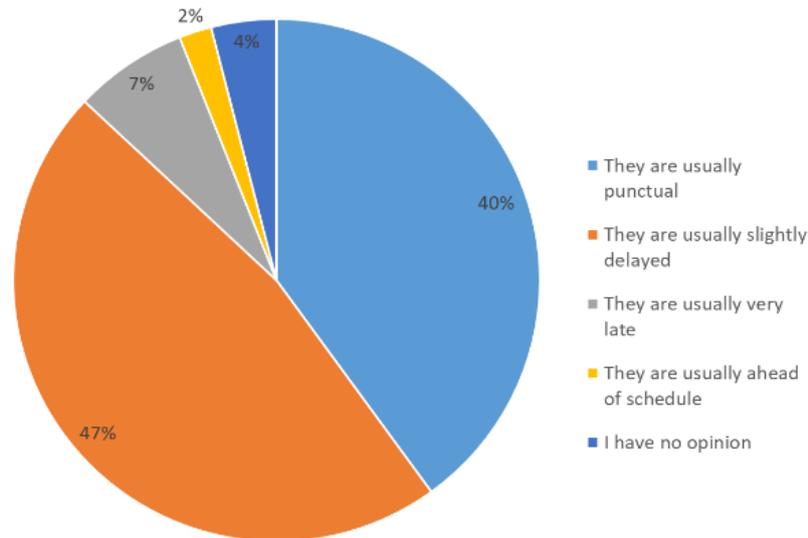
**Fig. 11** Distance traveled by travelers

In reference to the previous question about distance, passengers had been asked to rate the level of comfort during travel. According to 64% of respondents, trains ensure travel comfort. 24% believe that comfort is not provided on the trains. 12% did not express opinion on this question (Fig. 12).



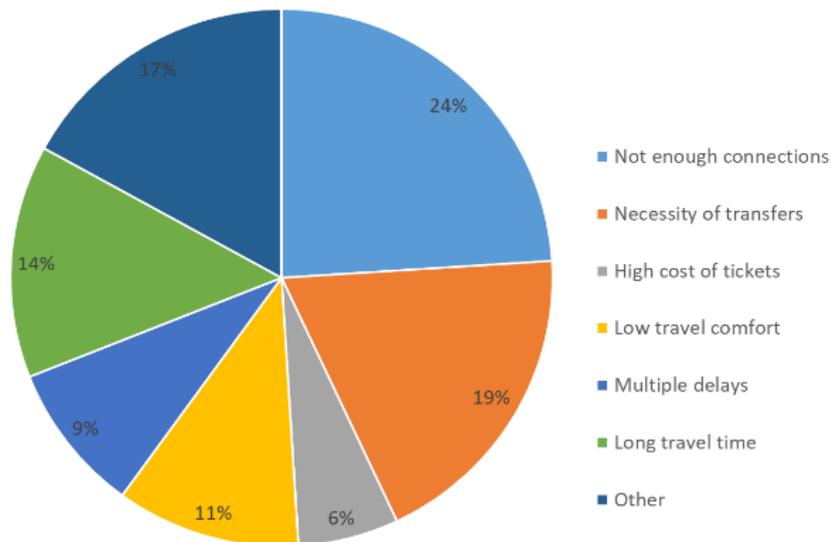
**Fig. 12** Assessment of travel comfort by train

A significant number of respondents (47%) think that trains are usually slightly delayed. 40% of respondents think that trains are usually on time. 7% of respondents complained about serious delays, while only 2% of respondents say that the arrival or departure of the train is premature. 4% of respondents did not express opinion (Fig. 13).



**Fig. 13** Delay tolerance

Q12 "Reasons for not using or rarely using PKP services"; the respondents gave the following answers (see Fig. 14): 24% of respondents mentioned the number of rail network connections is insufficient. 19% of respondents state need to change trains and 14% of respondent reasoned a long travel time. 11% of respondents find low travel comfort and 9% of respondents commented multiple delays and 6% percent of respondents reasoned high ticket cost. The remainder 17% of respondents had no need to travel, otherwise travel in a different mode of transport, or choose a different carrier (PKS).



**Fig. 14** Reasons for not using or rarely using PKP services

Additionally, an open-ended question on the survey, "What do you think could improve PKP's punctuality?" answered by 98 of the respondents with opinions as follows:

- Punctuality failures arise due to unrealistic impositions by the carriers that are technically impossible on the railway. Travel time set with too short duration at stops at intermediate stations, time too short for team change, etc. The concept of emergency rolling stock that should be replaced, if not eliminated.
- Punctuality failures arise due to difficulties on the tracks that require the recall of an active train
- Punctuality failures related to employees or the passengers of a given transport
- Punctuality improvement with more rail connections
- Punctuality improvement with better maintained railway network tracks

- Punctuality improvement by the increasing the permissible speeds,
- Punctuality improvement by competitiveness of carriers
- Punctuality improvement by optimizing the timetables of arrivals and departures
- Punctuality improvement by restructuring the organization of work and traffic flow
- Punctuality improvement by change of the ownership structure of railways in Poland
- Punctuality improves by increasing the number of employees
- Punctuality improves by increased number of trains running on a specific line
- Punctuality improves by modernization and systematic removal of technical issues
- Punctuality improvement by updating timetables, adjusting these to the actual travel time depending on the season and difficulty
- Punctuality improvement by organized of traffic at stations
- Punctuality improvement by synchronization of runs of other trains so that trains do not have to wait for each other
- Punctuality improvement by update of the offer with new connections, more direct connections.

## 5. Summary

Based on the observations and the conducted study of the punctuality of collective rail transport (TLK, IC, PREG), verified that last year delays on the designated routes did not constitute a major obstacle for travelers. On the part of the Carriers, there is an unprecedented effort to ensure a higher standard of punctuality in passenger transport. This aspect is important due to the trust of people using PKP services in planning a trip and choosing the means of transport. For this purpose, programs and projects of the Ministry of Infrastructure were created, on the basis of which the modernization of infrastructure and rolling stock planned for the coming years will be undertaken.

As in other types of transport of the PKP Company, not all inconveniences that may affect punctuality are controllable and easy to eliminate. Not all causes of delays can be easily categorized, which makes it difficult to identify; thus hinders the possibility of improvement.

In conclusion, delays should not take place, and if so, these should be minimized, especially delays that show some repeatability. Analyzing events that cause punctuality issues would help find solutions that eliminate travel delays. In addition to the types of causes of delays in passenger rail transport, this article presents ways to improve the punctuality of journeys.

Based on research from UTK statistics, it can also be said that the average punctuality of trains was 91.64%. The average punctuality is decreasing year by year. The Warsaw Commuter Railway is the most punctual. On the other hand, based on actual train punctuality surveys, it was found that IC and TLK trains are the most delayed. This may be mainly due to the long train routes, sometimes across Poland.

Based on the analysis of research on the punctuality of collective rail transport in 2019, early 2020 and taking into account the reports of the Rail Transport Office from previous years, it was noticed that there is a correlation between the actual occurrence of delays and the observations of travelers. People using collective rail transport attach importance to arriving at their destination on time (work, school, leisure, etc.). For travelers, it is important to run trains on time in accordance with the current timetable, as well as the number of direct connections and the comfort of travel.

The level of punctuality is satisfactory and delays in departure or arrival are not always the fault of the carrier. The surveyed carriers: Your Railway Lines, Intercity, Polregio are working on optimizing connections, modernizing the infrastructure, using clearer messages for locating passengers, repairing and replacing worn or defective means of transport. These operators make every effort to improve the rolling stock in order to eliminate the problem of delays. However, not all activities that improve punctuality are able to eliminate the occurrence of delays. Some of them are independent of the carrier and are difficult to predict.

This study can help to improve the punctuality of rail transport in Poland.

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Gorzelanczyk, P., Strzebiński, M. & Stanowski, P.; **data collection:** Gorzelanczyk, P., Strzebiński, M. & Stanowski, P.; **analysis and interpretation of results:** Gorzelanczyk, P., Strzebiński, M. & Stanowski, P.; **draft manuscript preparation:***

Gorzelańczyk, P., Strzebiński, M. & Stanowski, P. *All authors reviewed the results and approved the final version of the manuscript.*

## Appendix A:

### Research questionnaire

1. Gender:
  - a. Female
  - b. Male
2. Age:
  - a. Under 18 years old
  - b. 18 - 25 years old
  - c. 26 - 35 years old
  - d. 36 - 45 years old
  - e. Over 45 years
3. Education:
  - a. Elementary
  - b. Basic vocational
  - c. Secondary
  - d. Higher
4. Place of residence:
  - a. Rural
  - b. City
5. How often do you use the PKP?
  - a. Every day
  - b. Frequently (e.g., several times a week)
  - c. Occasionally (e.g., several times a month)
  - d. Rarely (several times a quarter)
  - e. Occasionally (several times a year)
  - f. Never (I use other means of transportation)
6. What is the purpose of your travel?
  - a. Work
  - b. School
  - c. Recreational trip (vacation, vacations)
  - d. Family/friends
  - e. Other
7. How would you rate the punctuality of trains?
  - a. Very good
  - b. Good
  - c. I have no opinion
  - d. Bad
  - e. Very bad
8. Distance you usually travel at one time:
  - a. Up to 50km
  - b. 50 - 100km
  - c. 100 - 150km
  - d. 150 - 200 km
  - e. 200 - 250 km
  - f. 250 - 300 km
  - g. More than 300 km
9. How would you rate the comfort of your trip?
  - a. Very good
  - b. Good
  - c. I have no opinion
  - d. Bad
  - e. Very bad
10. Tolerance for train delays:
  - a. They are usually on time
  - b. Usually they are slightly delayed
  - c. Usually they are severely delayed

- d. Usually they are ahead of schedule
- 11. Reasons for not using or rarely using PKP services (multiple choice):
  - a. Lack of a sufficient number of connections
  - b. The need for transfers (no direct connections to the destination)
  - c. High cost of tickets
  - d. Low comfort of travel
  - e. Numerous delays
  - f. Long travel time
  - g. Other (please write what are the reasons)
- 12. What do you think could improve the punctuality of PKP? (additional, optional question)?

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