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# Safety Issues of the Rail Transport System in Poland during COVID-19: A Review Based on Statistics and Research<sup>1</sup>

**Abstract:** The paper presents the characteristics of the rail transport system, including passenger and freight transport during the Covid-19 pandemic. The entities responsible for the safety of the railway sector were presented, among which were the Railway Transport Office, the company PKP PLK S.A., and the Railroad Security Guard, which played the most critical role. The paper presents statistical data for railway accidents and casualties in 2018–2021. It was noted that the Covid-19 pandemic significantly reduced passenger and freight transport. 2021 was the European Year of Railways; it was also an exceptional, demanding, and significant year for changes taking place on the railways. Throughout this time, the Office of Rail Transport promoted rail as a safe, ecological, and comfortable means of transport. Based on statistics and empirical research, the main problems of the railway sector were discussed, and the research hypothesis was verified positively.

**Keywords:** rail transport system, safety, Covid-19 pandemic, civil protection

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## Introduction

Rail transport is a means of transport using vehicles that run on tracks (rails or railroads). It is one of the most important, commonly used, and cost-effective modes of commuting and transporting goods over long and short distances (Economic Times, 2022).

Railway transportation includes intelligent transportation systems (ITS), vital in smart cities. They are gaining attention as promising to cope with the mobility challenges in large urban areas (López-Aguilar et al., 2022). Thanks to the miniaturization of sensors and the deployment of fast data networks, the railway industry is being augmented with contextual, real-time information that opens the door to novel and personalized services.

Rail transport in Poland is one of the main areas of economic development, which significantly affects freight and passenger transport safety (Pieniak-Lendzion & Stefaniak, 2019). The primary criterion determining the level of safety on the railways is the number of accidents and collisions.

The number of accidents taking place on the railroad depends on many factors: weather conditions, the condition of infrastructure and rolling stock, the intensity of rail traffic, vehicle operation, equipment failures, and defects or mistakes made by employees (Jaworska & Nowacki, 2018).

Level crossings have been critical points in rail traffic safety in Poland for years. On average, around 40% of all accidents on railway lines occur at crossings with roads. These incidents also account for around a third of all people killed and seriously injured (ORT, 2022).

The document concerning ensuring railway traffic safety in Poland is the National Railway Program until 2023 (NRP), a long-term program particularly important from the perspective of investments undertaken on railway lines. The program provides for many activities financed from the European Union budget, implemented in 2014–2020, to develop and modernize rail transport. In 2018, the expenditure on implementing its projects and investments amounted to PLN 17.8 billion (MI Program, 2020).

One of the critical tasks of the Ministry of Infrastructure in the transport field is to ensure railway traffic safety. The activities undertaken by the Ministry in this area relate to two levels (MI Safety, 2020):

- the area of soft activities, which is related to the preparation and implementation of documents relating to safety in rail transport,
- the area of complex actions, which concerns the modernization of the existing railway network and the implementation process of the European Rail Traffic Management System – ERTMS (Jaworska & Nowacki, 2019), including the European Train Control System (ERTMS/ETCS) and the Global System for Mobile Rail Radiocommunications (ERTMS/GSM-R).

Railway transport safety is a fundamental issue. It concerns not only legislation, organization, or traffic control but also the proper quality of every device in the railway

infrastructure. Safety is also directly responsible for protecting, e.g., level crossings and safety in design and construction (Burdzik et al., 2017).

The study aims to identify the existing threats and legal, organizational, and technological solutions and to evaluate the effectiveness of the railway transport system during the COVID-19 epidemic.

## **Problem, Hypothesis, and Methods**

The research problem was defined as follows: How does it function, and what is the effectiveness of the rail transport system in Poland during the COVID-19 pandemic?

The solution to the above problem is a research hypothesis: The rail transport system functions relatively correctly. However, in some situations, its activity is impractical due to defective organizational solutions, small competencies of key functional persons, incomplete and untimely monitoring of threats, incomplete legal regulations, and insufficient human and material resources.

Within the adopted research methodology, the following independent variable was distinguished for this study: the railway transport environment in Poland. The following indicators were adopted for the independent variable:

1. Legal and organizational requirements in the field of rail transport,
2. Social environment of employees in the railway sector,
3. Railway transport infrastructure is based on operational, control, and technical functions.

The dependent variable was determined: the functioning status of the railway transport system in Poland. The indicators adopted for the dependent variable are:

1. Professional competencies of employees in the railway sector,
2. Technical condition of infrastructure and rolling stock.

In order to solve the main research problem of the paper and verify the research hypothesis, qualitative and quantitative research methods were used:

- system analysis enabled the solution of the complex problem of the rail transport system;
- analogy was used to formulate a research hypothesis and search for similarities between issues in the field of rail transport safety;
- the statistical method allowed for the acquisition, presentation, and analysis of data describing accidents in rail transport;
- the analytical method allowed for the consideration of the organization of the rail transport system;
- a comparative method based on which basic mechanisms of safety implementation in the field of rail transport;
- behavioral method, which made it possible to recognize and explain by observing the behavior of passengers;

- Empirical methods: A diagnostic survey was conducted to collect data based on an anonymous questionnaire and expert interviews prepared for the study.

The deadline for conducting empirical research was 2020. Based on the survey questionnaire, 124 responses were received from various institutions. The prepared questionnaire form consisted of 19 questions concerning rail transport safety.

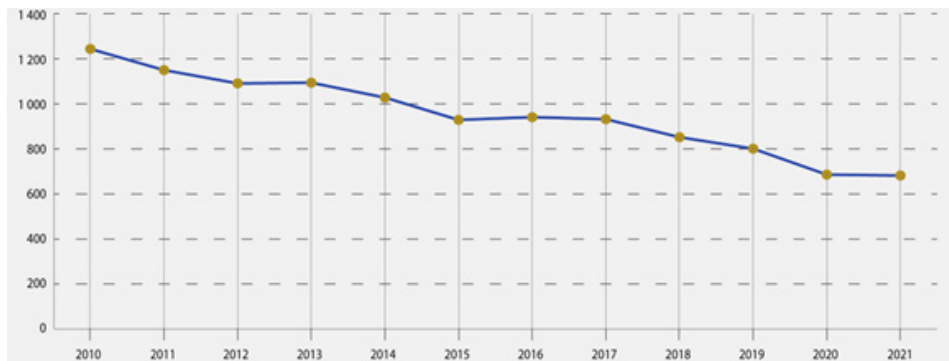
In the conducted research, the expert selection was used to get to know the point of view of people working in the railway sector with knowledge and experience. For this research, employees of the following institutions were examined:

- Office of Railway Transport (UTK),
- PKP PLK S.A. Company,
- PKP Cargo Group,
- State Commission for Investigation of Railway Accidents (PKBWK),
- Railway Security Guard (SOK),
- State Fire Service (PSP),
- Volunteer Fire Department (OSP),
- Police.

## Statistics on Passenger and Freight Transport

Between 2010 and 2021, the number of people killed in railway accidents in the EU (Eurostat, 2023) fell to 683 (– 562 deaths compared with 2010; – 45%). The COVID-19 outbreak also influenced the decrease in 2020, which continued from 2020 to 2021 (–1%).

Figure 1. People killed in railway accidents in the EU, 2010–2021



Legend: X – number of dead, Y – years from 2010 to 2021.

Source: Eurostat, 2023.

In 2021, 1,389 significant railway accidents were reported in the EU. A total of 683 persons were killed in these accidents, while another 513 persons were seriously injured. At the EU level, the number of fatalities in railway accidents decreased gradually over the

last decade, from 1 245 in 2010 to 683 in 2021, a fall of 45 %. However, it should be noted that from 2019 to 2021, the decreases in railway accidents, fatalities, and seriously injured persons coincided with a sharp drop in passenger transport by rail caused by the COVID-19 pandemic. The significant increase in remote working and homeschooling, combined with recommendations to avoid unnecessary travel during the pandemic, contributed to the rail passenger transport almost halving in the EU – see the article on railway Passenger transport statistics for more details (Eurostat, 2023).

Rail transportation safety is measured by an indicator of accidents per one billion passenger km. According to statistics, railway transport is one of the safest modes of transportation (Vojteka et al., 2020).

Work by the European Commission dating from 2019 suggested that the risk of death for a train passenger within the EU is around 0.09 fatalities per billion train kilometers, nearly one-third that for bus and coach passengers and around 28 times less than for car occupants (IRSC, 2023). 2023

Table 1. Fatality risk of passengers using different modes of transport in 2019 in the EU

Mode of transport	Fatalities per billion passenger km
Airline passenger	0.0800
Railway passenger	0.0900
Bus/Coach occupant	0.240
Car occupant	2.52
Powered two-wheelers	36.4

Source: IRSC, 2023; ERA, 2023.

In 2019, the most fatalities on Europe's rail networks were in Poland – 160, Germany – 137, Hungary – 87, Romania – 76 and France – 53.

In Poland, the pandemic and reduced mobility of travelers caused a decrease in passengers from 335 million in 2019 to 209 million in 2020. Workers, students, and pupils worked or learned remotely, and the use of public transport decreased. Rail freight carriers recorded slight drops. Intermodal transport was entirely immune to the pandemic (UTK operations, 2021).

The report shows that the COVID-19 pandemic mainly affected passenger transport. The number of passengers was even higher during the first two months of 2020 than in 2019. The drop in the number of travelers was in March, and it reached its lowest level in April. During the pandemic, limits on places in collective public transport were introduced. The transition to remote work and distance learning also reduced Poles' demand for travel.

Table 2. Passenger rail transport results in 2018–2021

Detail	2018	2019	2020	2021
number of passengers [m]	310	336	209	245
transport performance [m pass-km]	21,0 x 10 <sup>3</sup>	22,1 x 10 <sup>3</sup>	12,7 x 10 <sup>3</sup>	15,9 x 10 <sup>3</sup>
operating performance [m train-km]	166	171	160	178

Source: UTK, 2022.

In 2021, 245.1 million passengers traveled by rail. Compared to 2020, 35.7 million more passengers decided to travel by train (+ 17%). The transport performance amounted to 15.9 billion passenger-kilometers and was higher by 3.2 billion (+26%) yearly. In 2021, 243.6 million tons of goods were transported. Compared to 2020, 35.7 million passengers returned to the railroad, and the transported weight increased by 20.4 million tons. In passenger transport, the situation has not yet returned to the pre-pandemic state; however, freight transport was at a higher level than in 2019.

Table 3. Freight rail transport results in 2018–2021

Detail	2018	2019	2020	2021
weight [m ton]	250	236	223	244
transport performance [m ton-km]	59,6 x 10 <sup>3</sup>	55,9 x 10 <sup>3</sup>	52,2 x 10 <sup>3</sup>	56,0 x 10 <sup>3</sup>
operating performance [m train-km]	88,0	82,3	77,5	81,6

Source: UTK, 2022.

In 2019 and 2020, there was a significant decrease in the number of accidents in rail transport compared to 2018, where there were 641 accidents, while in 2021, there was an increase in the number of accidents, a total of 710, i.e., 69 more accidents (UTK Safety, 2021). As in recent years, most accidents occurred at railroad crossings. In 2020, 176 such events were recorded on railway lines, compared to 199 in 2019 (a decrease of 15%). In 2021, the number of these accidents increased to 236. In 2020, 149 people died in railway accidents, while 47 people were seriously injured. In 2020, 47 people died on rail-road and railroad crossings, i.e., 21.7% less than in the previous year (60 people were killed in 2019). In 2021, 236 accidents and collisions occurred at crossings (43 more than in 2020), 49 people died (5 more than in 2020), and 17 were seriously injured (3 less than last year).

Table 4. Number of accidents in 2018–2021

Detail	2018	2019	2020	2021
Total number of accidents	732	642	641	710
Number of accidents at level crossings and railway crossings	215	199	176	236

Source: UTK, 2022.

Table 5. Number of killed and injured in 2018–2020

Detail	2018	2019	2020	2021
Total number of fatalities	195	161	149	188
Number of fatalities at level crossings and railway crossings	49,0	60,0	47,0	43,0

Source: UTK, 2022.

In Poland, the greatest number of accidents and fatalities at level crossings and railway crossings in the EU mentioned reasons, railway stops, and stations should be located in places with significant demand for passenger rail transport characterized by a highly dense and diversity-rich land use structure (Soczówka & Żochowska, 2022).

### Results of Empirical Research

When answering questions 1a and 1b, most respondents assessed the safety level in passenger and freight transport as good (Table 6, 7). In passenger transport, the vast majority of respondents – 43 % – rated the current safety level at 4 (on a five-point scale), 35% of the respondents at 3, and 15% at 5. A small part of the respondents – 6 % – rated the passenger transport at 2, while the lowest rating was only one person admitted.

Table 6. How do you assess safety in rail (passenger) transport?

Assessment	Participants	%
1. Very bad	1	.8
2. Bad	7	5.6
3. Sufficient	44	35.5
4. Good	53	42.7
5. Very good	19	15.3

Table 7. How do you assess safety in rail (freight) transport?

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	13	10.7
3. Sufficient	53	43.4
4. Good	42	34.4
5. Very good	12	9.8

In passenger transport, the vast majority of respondents – 43% – rated the current safety level at 4 (on a five-point scale), 35% of the respondents at 3, and 15% at 5. A small part of the respondents – 6% rated the passenger transport at 2, while the lowest rating was only one person admitted. Moving on to freight transport, we also meet with divergent opinions of the respondents in this case – the largest group of people – 43% assessed rail freight

transport as 3, which is satisfactory. Good – 4 – was given by 34% of respondents, while the highest – 5 – 10% of respondents. Regarding negative opinions, the safety of freight transport was rated two by 11% of the respondents, while the lowest rating – 1 – was given by 2%.

Applicable legal regulations (international and national) should be written clearly and understandably, and national law should be coherent with international acts – tables 8 and 9 present the opinions of individual respondents on the topic mentioned above.

Table 8. How do you evaluate the binding legal regulations concerning the safety of railway transport?

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	6	4.8
3. Sufficient	61	49.2
4. Good	44	35.5
5. Very good	11	8.9

Table 9. What are, in your opinion, the biggest problems in the rail transport law?

Assessment	Participants	%
1. It is complicated	58	46.8
2. It is not suited to practice	55	44.4
3. It is not adjusted to international regulations	13	10.5
4. The rules are mutually exclusive	23	18.5
5. Does not take into account all threats	46	37.1
6. Others, what kind? *	6	4.8

Almost half of the respondents – 49% assessed the binding legal acts concerning the issues of rail transport safety sufficiently. A good mark was given by 35.5% of the respondents, and a perfect mark – 9%. 5% of the respondents assessed the functioning of legal provisions poorly, while 2% – very badly. By recording the given groups of answers into three categories: good, fair, and bad, we get the results that 44% of the respondents assessed the applicable legal regulations concerning rail transport safety as good, 49% as satisfactory, and 7% as bad.

According to the respondents, the biggest problem with existing legal regulations is too complicated (47% of respondents). A significant proportion of respondents also believe that the legal regulations in force are not adjusted to practice (44% of responses) and do not consider all threats (37% of responses). These are essential issues that significantly affect the safety of the railway sector, and they should be considered when updating and amending the existing legal provisions. According to the author, comprehensive detection



and identification of threats is crucial to the railway transport safety system. Going further, it should also be noted that almost every fifth respondent (19%) believes the existing provisions are mutually exclusive. About 11% of the responses were related to the fact that the legal conditions are not adjusted to international regulations. The confirmation of the above may be discrepancies in the understanding of some concepts, sometimes resulting from errors in the translation of some international documents.

Table 10. Opinions on the technical condition of railway infrastructure

Assessment	Participants	%
1. Very bad	1	.8
2. Bad	21	16.9
3. Sufficient	76	61.3
4. Good	26	21.0
5. Very good	-	.0

The survey showed that only 21% of the respondents assessed the technical condition of the railway infrastructure as good – it should be emphasized that none of the respondents chose a very good answer. As many as 41.6% of respondents assessed the infrastructure condition as sufficient, 33.3% – as bad, and 8.8% – as very bad. According to the presented data, over 83% of respondents assessed the condition of the railway infrastructure sufficiently, poorly, or very badly, which proves the scale of the problem faced by rail transport.

Table 11. Opinions on the technical condition of railway lines

Assessment	Participants	%
1. Very bad	4	3.3
2. Bad	19	15.4
3. Sufficient	71	57.7
4. Good	28	22.8
5. Very good	1	.8

Table 12. The results of the respondents' answers to question 5.2 (technical condition of the rolling stock)

Assessment	Participants	%
1. Very bad	1	.8
2. Bad	22	17.7
3. Sufficient	69	55.6
4. Good	32	25.8
5. Very good	-	.0

Table 13. Opinion on the technical condition of security, signaling, and communication devices

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	16	13.0
3. Sufficient	57	46.3
4. Good	41	33.3
5. Very good	7	5.7

Table 14. Opinion on the condition of railway and railway stations

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	20	16.1
3. Sufficient	70	56.5
4. Good	31	25.0
5. Very good	1	.8

Table 15. Opinion on the conditions of railway crossings

Assessment	Participants	%
1. Very bad	7	5.7
2. Bad	24	19.5
3. Sufficient	49	39.8
4. Good	41	33.3
5. Very good	2	1.6

Almost 58% of respondents assess the technical condition of railway lines as 3 (on a five-point scale). 23% of respondents for 4, 15% for 2, and 3% for 1, while the highest grade – 5, was marked by only one person. Regarding the technical condition of the rolling stock, like in the case of railway lines, the majority of the scores were 3 (56% of all responses). The grade 4 was given by 26% of the respondents, 2 – 17%, and the lowest grade – 1%. In the case of rolling stock, none of the respondents awarded the highest grade – 5. The respondents' opinions were quite divided regarding the technical condition of the equipment used in the railway sector. The vast majority of respondents – 46% – rated the current condition of the devices at 3. The highest scores – 4 and 5 were given by 39% of the respondents (4 – 33%, 5 – 6%, respectively). A small proportion of the respondents – 13% assessed the condition of the devices at two and only 2% at 1.

The survey showed that 56% of the respondents assessed the condition of railway stations and stations at 3, 25% at 4, 16% at 2, and 2% at 1. The highest grade – 5 was given by one person (1%). Regarding the last of the factors mentioned for the assessment – the

condition of railway crossings – in this case, 3 – 44% scores prevailed. The highest scores – 4 and 5 – were given by 35% of the respondents, while the lowest scores were 2 and 1 – 19% and 6%, respectively. When analyzing in detail the responses given by the respondents on individual elements of the railway sector, it should be emphasized that, in principle, for each of the factors, the assessment – 3 on a five-point scale prevailed. Out of all the outlined elements, the technical condition of devices (safety, signaling, and communication) was best assessed – 39% of respondents rated the condition as 4 or 5, and the condition of railway crossings – 35% of respondents assessed the technical condition of the railway infrastructure as 4 or 5 and rolling stock – in both cases about 75%. As for the other answers (question 5.6) and the indication of the railway system elements not mentioned by the author for the assessment of their condition, an additional answer was given by five people (N = 5), who indicated such elements as freight rolling stock, fire protection belt and the condition of electric traction.

Table 16. Assessment of the elements of the railway system requiring modernization

Assessment	Participants	%
1. Rolling stock	74	59.7
2. Railway lines	<b>80</b>	<b>64.5</b>
3. Railway crossings	63	50.8
4. Railway stations and railway stations	47	37.9
5. Loading/transshipment sites	12	9.7
6. Devices and equipment	23	18.5
7. Bridges, tunnels, passages over and under the tracks	26	21.0
8. Others, what kind?	3	2.4

According to the respondents, railway lines are the main element of the railway infrastructure requiring modernization (64.5% of all responses). The Republic of Poland has one of Europe’s most extended railway networks (behind France and Germany). However, its condition still differs from European standards and, in many cases, is described as unsatisfactory. The second factor indicated by the respondents, which in the first place requires modernization, is also the rolling stock (60% of responses). According to more than half of the respondents – 51% of the answers – railway crossings require modernization, and 38% believe that railway stations and stations require reconstruction. Bridges, tunnels, and crossings over and under the tracks were classified among the less popular answers – 21% of which are modernized. Less than 1/5 of all answers (19%) were about devices and equipment – the condition in the previous question was rated the highest by the respondents. As the element of the railway system least requires restructuring, the respondents indicated the places of loading and reloading of goods (10%).

Table 17. Opinion on the level of knowledge, education, and competencies of employees

	Assessment	Participants	%
1. Very bad		3	2.4
2. Bad		10	8.10
3. Sufficient		38	30.9
4. Good		66	53.7
5. Very good		6	4.9

Another element examined in the survey was the level of knowledge, education, and competencies of employees in the railway sector. Most respondents, as many as 53.7%, believe that the railway staff has a good education, and 4.9% have a very good competency to perform the function in the position held. 31% of respondents believe employees have sufficient knowledge and competencies (grade 3 on a five-point scale). Only 10% of respondents rated the discussed features at 2 or 1.

Table 18. Which institutions play a leading role in ensuring rail transport safety in Poland?

	Institution	Participants	%
1. Office of Rail Transport		82	66.1
2. PKP S.A.		68	54.8
3. Ministry of Infrastructure		22	17.7
4. Supreme Chamber of Control		4	3.2
5. State Commission for Investigation of Railway Accidents		20	16.1
6. Others		11	8.9

According to as many as 66% of respondents, the Railway Transport Office is the institution most involved in ensuring rail transport safety. In the second place, the respondents indicated the company PKP PLK S.A. – 55% of responses and the Ministry of Infrastructure – 18%. The State Railway Accident Investigation Commission took the following positions – 16% and the Supreme Audit Office – 3%. As for the answer, 11 people indicated the remaining institutions guaranteeing safe transport: the Railway Security Guard, the Police, and operation and maintenance services.

Table 19. Do you think rescue services in Poland have sufficient forces and means to carry out a rescue operation during a terrorist attack on railway infrastructure facilities?

	Assessment	Participants	%
1. Yes		39	31.5
2. No		33	26.6
3. I have no opinion		52	41.9

In the assessment of 31% of respondents, rescue services have sufficient strength and means to carry out a rescue operation during a terrorist attack. The opposite opinion is shared by 27% of respondents, according to which the services do not have the equipment and knowledge adequate to the discussed hazard. A significant proportion of respondents – 42% – chose the answer – I have no task, thus refraining from a biased answer. People from this group gave the justification that so far, no terrorist attacks have occurred in Poland.

Moving on to the answers of open respondents, 23% of respondents justified their opinion – the justifications concerned mainly negative assessments. The respondents argued their critical opinion with the lack of specialist equipment, staff shortages, and insufficient training courses in rescue operations in the event of terrorist events.

Table 20. How do you evaluate the system of predicting, preventing, and detecting threats in railway areas?

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	14	11.3
3. Sufficient	61	49.2
4. Good	40	32.3
5. Very good	7	5.6

Nearly half of the respondents (49%) said the system of predicting, preventing, and detecting threats is sufficiently effective. 32% of respondents assessed the above system as good, but 6% said it was very good. Regarding negative opinions, 13% of respondents gave them (11% rated the threat detection system poorly, and only 2% rated it very bad).

Despite the positive assessments of the respondents, it should be remembered that the security environment is constantly changing, and new threats are constantly appearing among the existing threats. Therefore, it is necessary to adapt the existing systems to the constant changes taking place. The most important thing is the early recognition of emerging threats and the prevention of their escalation.

Table 21. Do you think the control system of people and goods transported by rail is well organized?

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	13	10.5
3. Sufficient	70	56.5
4. Good	35	28.2
5. Very good	4	3.2

Regarding the respondents' responses, 57% assessed the system of control of the transported people and goods sufficiently – 31 % were good or very good, and 12% were bad or very bad.

Table 22. How do you evaluate the cooperation between rescue services in Poland during railway accidents and disasters?

Assessment	Participants	%
1. Very bad	1	.8
2. Bad	6	4.8
3. Sufficient	25	20.2
4. Good	75	60.5
5. Very good	17	13.7

The work of emergency services was assessed as good (60% of responses) and very good (14% of responses) in the vast majority of cases (by as much as 74% of respondents). This proves that the respondents appreciate well-functioning rescue systems, quick interventions, effective rescue operations, and the diligent work of the personnel. Every fifth respondent assessed the cooperation between services sufficiently, while 6% of the respondents assessed it badly or very badly.

Moving on to the open part of the question under analysis, 47% of the respondents (N = 58) justified their answers. According to the respondents, the rescue operations are carried out professionally, the reaction time is short, the rescuers are dedicated to their work, and various services complement each other when performing their tasks. When analyzing the respondents' responses, it should be emphasized that the emergency services respond well to emerging threats, and their cooperation is satisfactory. Despite the generally positive assessment of cooperation between rescue services and the advantages of the system in place, the respondents indicated several disadvantages and shortcomings that should be worked on to increase safety. Among the defective elements hindering cooperation, the respondents indicated, among other things, poor communication between services, insufficient training, lack of joint exercises, outdated equipment, incomprehensible procedures, and staff shortages. Several people also indicated the long time of the accident commission meeting as a critical point of cooperation, as well as problems noticeable at the level of cooperation with the prosecutor.

Table 23. Do you think rescue services in Poland have sufficient forces and means to carry out a rescue operation during a terrorist attack on the railway system's infrastructure facilities?

Assessment	Participants	%
1. Yes	39	31.5
2. No	33	26.6
3. I have no opinion	52	41.9

In the assessment of 31% of respondents, rescue services have sufficient strength and means to carry out a rescue operation during a terrorist attack. The opposite opinion is shared by 27% of respondents, according to which the services do not have the equipment and knowledge adequate to the discussed hazard. A significant proportion of respondents – 42% – chose the answer – I have no task, thus refraining from a biased answer. People from this group gave the justification that so far, no terrorist attacks have occurred in Poland.

Moving on to the answers of open respondents, 23% of respondents justified their opinion – the justifications concerned mainly negative assessments. The respondents argued their critical opinion about the lack of specialist equipment, shortages of staff, and insufficient training courses in rescue operations in the event of terrorist events. First of all, it is necessary to constantly invest in human potential and improve the competencies of rescuers. To this end, it is necessary to increase the number of organized courses and training, as well as exercises in the form of simulations of terrorist attacks carried out on railway facilities, the task of which will be to check the effectiveness and cooperation of services, as well as to develop specific patterns, algorithms, and procedures. The critical issue is retrofitting rescue units with specialized equipment, enabling access to railway lines.

Table 24. Is the control system of people and goods transported by rail well organized?

Assessment	Participants	%
1. Very bad	2	1.6
2. Bad	13	10.5
3. Sufficient	70	56.5
4. Good	35	28.2
5. Very good	4	3.2

Regarding the respondents’ responses, 57% assessed the system of control of the transported people and goods sufficiently – 31 % were good or very good, and 12% were bad or very bad.

When analyzing the safety control of transported people and loads, it should be emphasized that this system does not function to a large extent in the case of rail transport. Mainly, the transported loads are inspected. Due to the great interest in this branch of transport and the mass travels of people using the railway infrastructure, it is not possible to check all passengers, their luggage, and transported goods – to the same extent as, for example, in the case of air transport and security checks carried out. Taking such actions would result in high costs and queues at the gates, extending the waiting time for trains and, consequently, reducing the competitiveness of rail transport. In this case, the rail sector should focus more on monitoring the transported goods, early identification of threats, and adequate preparation to respond to emerging dangers.

Dangerous goods constitute a particular class of goods transported by rail transport. These are substances whose transport is prohibited or allowed under strictly defined con-

ditions regulated by relevant documents. Due to the chemical properties of dangerous goods, many risks are associated with their transport. In the event of accidents or accidents involving these substances and materials, contamination of soil, water, air pollution, and numerous fires hazardous to people, animals, plants, and the environment may occur. In order to assess the functioning of the transport of dangerous goods by rail, the following survey question was devoted to this problem.

Table 25. How do you assess the organization of transporting dangerous goods by rail in Poland?

Assessment	Participants	%
1. Very bad	-	.0
2. Bad	4	3.2
3. Sufficient	50	40.3
4. Good	62	50.0
5. Very good	8	6.5

Most respondents positively assessed the organization of transporting dangerous goods by rail. As many as 57% of the respondents gave good and very good grades, and 40% believe that transporting dangerous goods is sufficiently organized. As for negative responses, only 3% of the respondents chose them (only bad, not very bad). The respondents' responses testify to the excellent organization of the transport of dangerous goods; however, bearing in mind the risks related to transporting these loads, it is essential to remember about constant supervision, monitoring, and control of the entire transport process.

The data presented in Table 26 show that the respondents indicated the technical condition of railway lines – 64% of all responses – and the technical condition of the rolling stock – 53% of responses as the main factors negatively affecting the safety of the railway system. Subsequently, hooligan activities were classified as problematic, significantly contributing to training delays – 31% of responses, and professional competencies and training of employees – 16%. The respondents indicated the behavior of road users and pedestrians as other factors affecting the safety of the railway system. As we know, most railway accidents and incidents are caused by inappropriate behavior of drivers and people entering the track.

Table 26. What factors, in your opinion, harm the safety of rail transport?

Issue	Participants	%
1. Technical condition of railway tracks	79	63.7
2. Technical condition of the rolling stock	66	53.2
3. Functioning of railway crossings	27	21.8
4. Professional competencies and training of employees	20	16.1
5. Hooligan activities	38	30.6
6. Others, what kind?	2	1.6



According to the respondents' opinions, the critical points of rail transport are still insufficiently modern infrastructure and rolling stock. The railway sector has recently attempted to modernize and restructure the existing railway network. It is also the beneficiary of numerous investment programs to renovate and expand the rolling stock. The answers of the people participating in the study also confirm the main hypothesis of this research, in which the author indicated the condition of infrastructure and rolling stock, as well as the professional competencies of employees, as the main factors affecting the safety of the railway sector.

Table 27. What actions, in your opinion, would increase the safety level of rail transport?

Issue	Participants	%
1. Amendment of legal acts	18	14.5
2. Modernization and expansion of railway lines	95	76.6
3. Purchase of modern rolling stock	82	66.1
4. Improving the competencies and skills of employees	61	49.2
5. Technological innovations	46	37.1
6. Reorganization of the rescue system on the railroad	7	5.6
7. Others, what kind?	4	3.2

By analyzing the opinions of the respondents and considering that they could indicate several factors in their responses, not one element – we can distinguish the three most important types of activities, the taking of which will positively affect the safety of the railway sector. First, the respondents indicated the modernization and expansion of railway lines – 77% of responses, then the purchase of modern rolling stock – 66% of responses and the improvement of employees' competencies and skills – 49% of responses. Moving on to the other variants of answers, technological innovations accounted for 37% of responses, amendments to legal acts – 15%, and the reorganization of the rescue system – 6%. Regarding other answers, the respondents indicated, among others, the following solutions: expansion of the monitoring system in all rolling stock and replacement of railway crossings with viaducts or tunnels. Admittedly, these are exciting solutions that should be taken into account. As mentioned in Chapter 2, the most significant number of railway accidents occur at level crossings. Therefore, it can be assumed that limiting their number would significantly reduce the number of accidents and thus increase the safety level of the entire railway system.

Table 28. What effects should the new concept of the railway transport safety system bring?

Issue	Participants	%
1. Improving the safety of the performed transport	65	53.4
2. Amendment of legal acts	20	16.1
3. Early detection of threats	68	54.8
4. Modernization of railway infrastructure	72	58.1
5. Raising the level of competencies and education of employees in the railway sector	35	28.2
6. Better cooperation between railway carriers	31	25.0
7. Improving cooperation between emergency services	15	12.1
8. Increased control of transported goods	14	11.3
9. Others, what kind?	2	1.6

In the opinion of most respondents, the new concept of the railway transport safety system should be focused on the modernization of the railway infrastructure, early detection of threats, and general improvement of the safety of the performed transports. The respondents also indicated significant effects of the increase in the level of competencies and education of employees in the railway sector, as well as the improvement of cooperation between railway carriers. In the opinion of most respondents, the new concept of the railway transport safety system should be focused on the modernization of the railway infrastructure, early detection of threats, and general improvement of the safety of the performed transports. The respondents also indicated significant effects of the increase in the level of competencies and education of employees in the railway sector, as well as the improvement of cooperation between railway carriers.

## Conclusion

The research problem of the thesis was formulated in the following question: How does the railway transport system in Poland function, and how effective is it during the Covid-19 pandemic? In order to answer the question posed, a detailed analysis of the literature was undertaken, and empirical research was carried out. This allowed for positive verification of the research hypothesis: The railway transport system functions relatively correctly, but in some situations, its operation is not practical due to defective organizational solutions, small competencies of key functionaries, incomplete and untimely monitoring of threats, incomplete legal regulations and insufficient human resources and in kind.

The obtained research results prove that the aim of the research has been achieved. The adopted main hypothesis was positively verified in its entirety.

From the responses presented, there are several problems faced by rail transport. The first and most important one is the condition of the functioning railway infrastructure, especially the railway lines. In order to improve the safety of the railway system, an important issue is the renovation and expansion of the existing railway network, which will significantly

improve transport processes and increase the quality of services provided. The situation is similar in the case of rolling stock; despite numerous investments related to new train sets, many vehicles still require comprehensive renovation, which is emphasized by the respondents' responses.

The modernization and restructuring of the Polish railway network and rolling stock are the most essential challenges railway market entities face. They require appropriate legal regulations and extensive investment programs.

Raising the qualifications of employees is particularly important and is of great importance for the safety of the railway system.

The cooperation of rescue services is assessed positively. Lifeguards have a good reputation among the public, and their dedication is appreciated. Considering that the number of rescue actions carried out every year increases and the catalog of threats is infinite and constantly evolving, it is necessary to strive for the modernization and development of rescue services to increase the effectiveness and efficiency of the actions taken.

Changes in the threat environment, the growing demand for travel, and ever-new communication technologies mean that existing transport systems, including rail, must follow new trends and constantly expand their service offerings.

The number of passengers and goods transported using rail is growing yearly. Along with the increased number of performed transports, threats increase proportionally. The railway sector faces several challenges related to identifying threats, guaranteeing safety, and increasing the quality of the provided transport services.

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