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CHANGES IN THE FUNCTIONING OF PASSENGER RAIL TRANSPORT IN POLAND DUE TO THE COVID-19 PANDEMIC

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Purpose: The purpose of this article is to examine the changes in the functioning of passenger rail transport in Poland due to the COVID-19 pandemic, focusing on shifts in passengers' transport preferences before and during the pandemic, as well as evaluating the preparedness of rail carriers in adapting to pandemic-related restrictions.
Design/methodology/approach: The research was conducted using a survey questionnaire composed of 11 questions, which collected responses from 366 participants across Poland. The study adopts an empirical approach to understand passengers' experiences and opinions on rail transport during the pandemic, focusing on their transport preferences and perceptions of carriers' preparedness.
Findings: The survey results show that the majority of passengers positively assessed the actions taken by rail carriers during the COVID-19 pandemic. The findings indicate a general satisfaction with the measures implemented to ensure safety and compliance with health guidelines, as well as a shift in passengers' transport preferences during the pandemic.
Research limitations/implications: The study is limited by the number of respondents (366), which may not fully represent the entire population of rail passengers in Poland. Future research could expand the sample size and explore a broader range of transport modes or compare the situation in other countries to provide a more comprehensive understanding of the pandemic's impact on public transport.

Practical implications: The research highlights the importance of adaptive measures in ensuring the continued functioning of rail transport during global crises such as the COVID-19 pandemic. Rail operators can use these insights to refine their contingency planning and improve crisis management strategies to maintain passenger trust and safety in future emergencies.
Originality/value: This article offers new insights into the specific challenges faced by passenger rail transport in Poland during the COVID-19 pandemic, as well as passengers' evolving preferences and expectations. It is valuable for transport policymakers, rail operators, and researchers interested in transport resilience and crisis management.
Keywords: passenger rail transport, COVID-19 pandemic, restrictions, proposals for improvement.
Category of the paper: Research paper.

1. Introduction

The COVID-19 pandemic has fundamentally altered various sectors of the global economy, with transportation being one of the most impacted areas (Dong et al., 2012). In Poland, passenger rail transport, a crucial component of the country's public transportation system, has faced unprecedented challenges due to the health crisis. As governments implemented lockdowns and social distancing measures, the volume of rail passengers plummeted, leading to significant operational and financial repercussions for rail carriers (Jahangiri et al., 2018).

Prior to the pandemic, rail transport in Poland was experiencing a renaissance, with increasing passenger numbers and investments in modernizing infrastructure. However, the onset of the pandemic necessitated a rapid adaptation to a new reality, compelling rail operators to reassess their strategies and operations (Lin et al., 2020; Zhou et al., 2020). Understanding these changes is vital for evaluating the resilience and adaptability of the rail transport sector in crisis situations.

This article aims to examine the changes in the functioning of passenger rail transport in Poland due to the COVID-19 pandemic. It will analyze shifts in passengers' transport preferences before and during the pandemic and evaluate the preparedness of rail carriers in implementing pandemic-related restrictions (Mohammadfam et al., 2020; Woodburn et al., 2019). By employing a quantitative approach, the study will provide insights into how the pandemic has reshaped passenger rail transport in Poland, revealing not only the immediate effects but also the potential long-term implications for the industry.

2. A Historical Perspective on Coronaviruses: From Early Discoveries to the COVID-19 Pandemic

Coronaviruses have been known in human medicine for a long time. The first mentions of coronaviruses that can infect humans date back to the 1960s. At that time, it was possible to isolate the first two pathogens causing respiratory diseases in humans, and for decades they were the only representatives of coronaviruses that could infect humans (Tyrrell, Bynoe, 1965). It was not until the beginning of the 21st century that the world was swept by an epidemic caused by the highly contagious SARS-CoV coronavirus species. Another wave of infections with the novel coronavirus took place in 2012 in the Middle East. This time the virus was called MERS-CoV and, like the previous one, it was a zoonotic virus (Coronavirus number infected latest tally). However, these epidemics did not pose a worldwide threat to humans.

The first cases of the new infectious disease-causing pneumonia were registered on November 17, 2019 in the city of Wuhan, in China's Hubei province. All of the infected people were associated with the Huanan Seafood Wholesale Market, a seafood and animal market located in the town. At the beginning of January 2020, Chinese scientists isolated a new virus genetically similar to the SARS-CoV virus from samples taken from patients, which is why it was named SARS-CoV-2. The infectious disease caused by this virus has been named COVID-19 (Coronavirus: China’s first confirmed Covid-19 case traced back to November 17).

Initially, the virus spread among the people of Wuhan. However, the movement of Chinese people in connection with the Chinese New Year celebrations has greatly facilitated the development of infections at home and abroad. On January 13, 2020, the first case was confirmed in Thailand. The first cases of infection in Europe were confirmed on January 24, 2020, in three residents of France (Three cases of coronavirus in France. These are the first infections in Europe). The second half of February resulted in a sharp increase in the number of cases around the world. At that time, Italy became the most affected region in the world. In April 2020, the highest number of infections was recorded in the United States, which led the way until March 2021. Due to the situation, on 11 March the Director-General of the World Health Organization (WHO) described the development of the disease as a pandemic (World Health Organization Declares COVID-19 a 'Pandemic.' Here's What That Means).

In Poland, the first case of SARS-CoV-2 infection was reported on March 4, 2020. The virus infection was diagnosed in a hospital in Zielona Góra, in a resident of the Lubuskie province, who came to Polish by bus from Germany (First cases of coronavirus in Poland). In the period from 14 to 20 March, a state of epidemiological emergency was in force in Poland. In the period from 20 March 2020 to 15 May 2022, in accordance with the regulation of the Minister of Health, the state of epidemic was in force in Poland (Regulation of the Minister of Health of 20 March 2020 on the announcement of the state of epidemic in the Republic of Poland). As of May 16, 2022, the state of epidemiological emergency is in force again.

According to the draft regulation of the Minister of Health published on 2 May 2023 on the website of the Government Legislation Centre, the state of epidemiological threat in Poland is to end on 1 July 2023 (Hilgenfeld and Peiris, Regulation of the Minister of Health of 12 May 2022 on the announcement in the territory of the Republic of Poland).

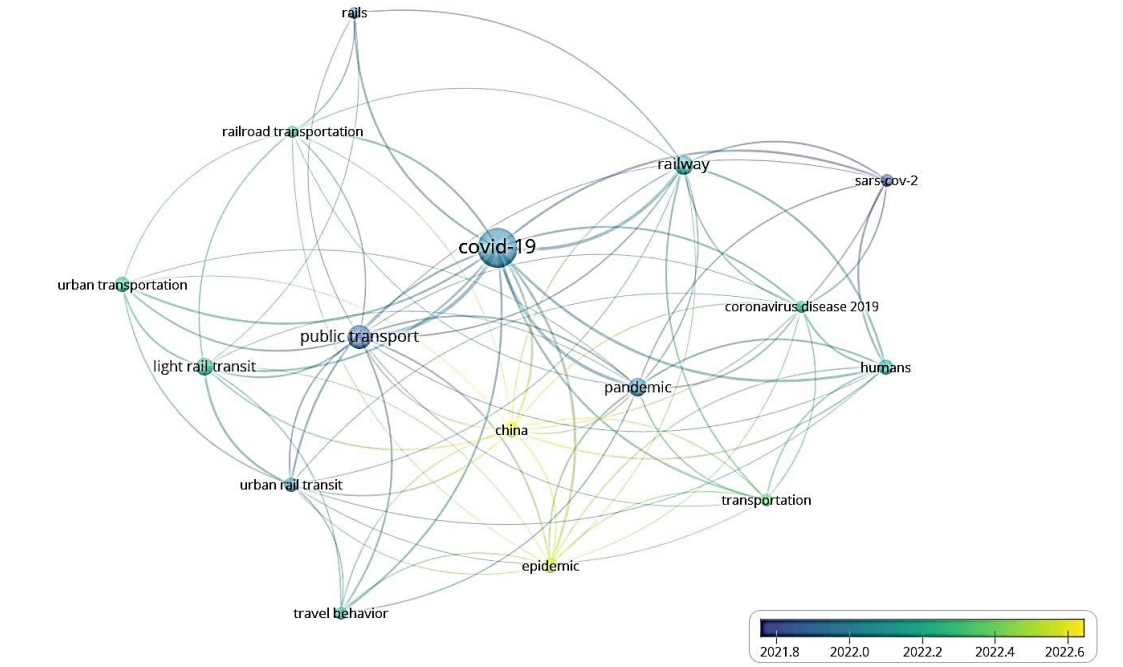
3. A review of literature studies on the Covid-19 pandemic and the functioning of rail transport over time

The COVID-19 pandemic had a huge impact on various economic sectors around the world, and one of the most affected areas was passenger transport. Assessments of the impact of the pandemic on passenger rail transport were carried out using bibliometric analysis with VOSviewer. According to the Scopus database, approximately 79 different studies were conducted in the declared area from 2020-2024. The results of this scientometric analysis are shown in Figure 1.

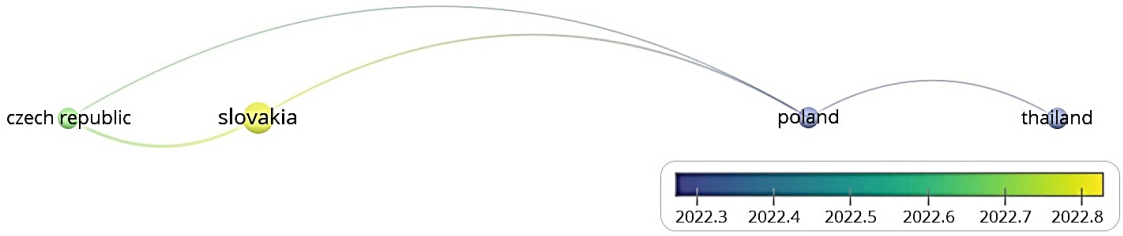
As illustrated in Figure 1a, it is evident that the impacts of Covid-19 have been evaluated from various perspectives, including public transportation, railroad system effects, human feedback, and urban transportation systems. The bibliometric analysis based on the Scopus database revealed that this topic remained of significant interest, particularly in China, even after 2022.

The detailed analysis shows that the studies cover a broad range of aspects. Public transportation research primarily focuses on the decline in passenger numbers, changes in travel behavior, and adaptations in service operations. Railroad system effects include the analysis of operational efficiency, economic impacts, and infrastructural adjustments necessitated by the pandemic. Studies on human feedback emphasize passenger perceptions, behavioral changes, and compliance with safety measures. Urban transportation system research delves into the broader implications for city mobility and integration with other forms of transport.

Additionally, Figure 1b demonstrates that the topic remains a significant issue in Poland. The country has engaged in joint projects related to this field with the Czech Republic, Thailand, and Slovakia. This collaboration indicates that the subject of Covid-19's impact on passenger rail transport is an attractive and active research area in Poland. These international collaborations suggest a shared interest in understanding and mitigating the effects of the pandemic on rail systems. The research conducted in Poland, often in partnership with other countries, underscores the global nature of the challenges faced and the collective effort to develop effective solutions. This collaborative approach not only enhances the quality and scope of research but also facilitates the exchange of knowledge and best practices among countries facing similar issues in their transportation sectors.



(a)



(b)

Figure 1. The bibliometric analysis of Covid-19 effects on rail transport system as per Scopus databank. Source: Own material.

It should be noted that understanding and mitigating the impact of the pandemic on rail transport cannot be effective without considering the context in which Poland faced the pandemic. From March 2020 to November 2022, there were six waves of increased SARS-CoV-2 infections in Poland. The first wave with confirmed daily infections, in the amount of about a thousand people a day, took place in August 2020. The second wave with confirmed daily infections of about 25,000 took place in November of the same year. The third wave reached Polish in the spring of 2021. At that time, more than 30,000 infections were recorded daily in Poland. The fourth wave reached our country at the end of 2021 – with confirmed infections at the level of 25 thousand per day. Soon after, in February 2022, the fifth wave of infections reached Polish. At that time, more than 50,000 confirmed infections were recorded. The last wave of the epidemic in Poland lasted from July to October 2022, with the daily number of confirmed infections at the level of several thousand per day. According to the data published on websites, 6 million 516 thousand 234 cases of SARS-CoV-2 infection have been confirmed in Poland since the beginning of the pandemic.

Unfortunately, 119 thousand 596 people died of COVID-19 in Poland (Coronavirus number infected latest tally). Figure 2 shows a graph with the daily number of confirmed infections from the beginning of the pandemic to May 2023.

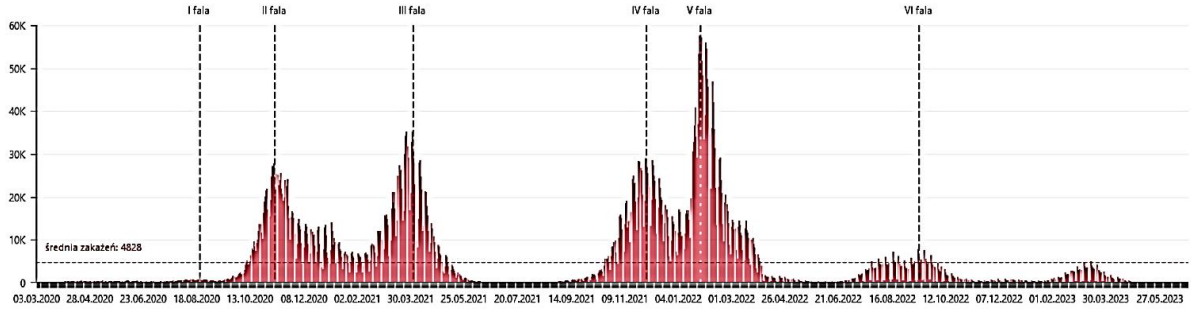


Figure 2. Daily number of confirmed infections from the beginning of the pandemic to May 2023.
Source: Information of the Chief Sanitary Inspector on mass events.

During this time, i.e. from March 2020 to March 28, 2022, various restrictions were introduced throughout the country. These were aimed at reducing the spread of the virus. The chronological dates of the introduction of restrictions and the dates of their easing in Poland are presented below.

- March 8, 2020 – The Chief Sanitary Inspector recommended the cancellation of all mass events with more than a thousand people – this applied to closed rooms (Information of the Chief Sanitary Inspector on mass events).
- March 10, 2020 – the majority of rectors of universities in Poland have decided to cancel classes for students and doctoral students from 11 to 14 March. On the same day, at a meeting of the National Security Council, Prime Minister Mateusz Morawiecki cancelled all mass events throughout the country (Action on coronavirus in Poland).
- March 11, 2020 – The Prime Minister and the Ministers of Health, National Education and Higher Education announced the preventive closure of all educational institutions for a period of 14 days – from 14 to 25 March 2020. This applied to all public and private schools, nurseries, kindergartens, as well as secondary schools and universities. These restrictions did not apply to special schools, educational centres and counselling and guidance centres (Coronavirus in Poland schools and kindergartens closed).
- March 13, 2020 – The Minister of Health announced that from 14 March 2020 a state of epidemiological emergency will be introduced in Polish (Regulation of the Minister of Health of 13 March 2020 on the announcement of the state of epidemic threat in the Republic of Poland). And from March 15, the borders of Polish will be closed. This restriction applied to air and rail traffic. At that time, passport controls were also introduced at all land border crossing points. Only workers working in border areas were allowed to enter the country upon presentation of the appropriate certificate. Polish citizens returning from abroad had to undergo a 14-day quarantine. At that time,

a ban on public gatherings of more than 50 people was introduced, including during state and religious ceremonies (State of epidemiological emergency).

- March 20, 2020 – on this day, the state of epidemic was declared in the Republic of Poland by the regulation of the Minister of Health. This state of affairs was in force until 16 May 2022 (Regulation of the Minister of Health of 20 March 2020 on the announcement of the state of epidemic in the Republic of Poland).
- March 25, 2020 – from that date, new safety rules related to COVID-19 were introduced. Gatherings of more than 2 people were banned, participation in religious ceremonies was limited to 5 people, and restrictions on movement by public transport and on foot were introduced.

  At that time, the following principles were adopted:

  1. for public transport – the maximum number of passengers in public transport may not exceed half of all seats in the rolling stock,
  2. for pedestrians – two people could move at the same time at a distance greater than or equal to 1.5 meters (this restriction did not apply to people living in the same household). A ban on movement was also introduced (Regulation of the Minister of Health of 24 March 2020 amending the regulation on the announcement of the state of epidemic in the Republic of Poland).

  This prohibition did not apply to:

  1. performing official tasks or professional activities, conducting business activity, carrying out agricultural activity or work on the farm, and purchasing goods and using related services,
  2. meeting the necessities of life related to the affairs of everyday life,
  3. performing voluntary and unpaid – also in the form of volunteering – services to counteract the effects of COVID-19,
  4. worship or participation in religious worship, as well as religious rites (Regulation of the Minister of Health of 24 March 2020 amending the regulation on the announcement of the state of epidemic in the Republic of Poland).
- April 1, 2020 – further restrictions were introduced on that day to reduce the spread of the SARS-CoV-2 virus. Parks, boulevards and beaches were closed. Hairdressing salons, beauty salons and tattoo parlors were suspended. Persons under the age of 18 were allowed in public spaces only under the supervision of an adult guardian. In shops and service outlets, the number of customers could not exceed three times the number of cash registers. The so-called "senior hours" were introduced in supermarkets – this meant that from 10:00 a.m. to 12:00 p.m., only people over 65 years of age could be in stores. All stores had to equip staff with personal protective equipment, and customers were only allowed to wear protective gloves (Regulation of the Council of Ministers of 31 March 2020 on the establishment of certain restrictions, orders and prohibitions in connection with the state of epidemic).

- April 20, 2020 – the first stage of lifting restrictions began in Poland. The ban on movement for "recreational purposes" has been lifted. The limits of people who could be in shops and places of worship at one time were increased. The new limit allowed 1 person per 15 m^2. The age limit for people moving in public spaces has been reduced. From that day on, people under the age of 13 had to stay with an adult guardian, and not 18-year-olds as before (Regulation of the Council of Ministers of 19 April 2020 on the establishment of certain restrictions, orders and prohibitions in connection with the state of epidemic).
- May 4, 2020 – the second stage of lifting restrictions began. This stage included, among other things:
  1. opening of shops in shopping centres and shopping malls, provided that the strict sanitary regime is observed,
  2. hotels have been opened and other accommodations have been allowed,
  3. rehabilitation for patients was launched,
  4. some cultural institutions were opened, such as libraries, museums and art galleries,
  5. small group organisations – childcare in crèches and kindergartens (for working parents) – has been allowed,
  6. the possibility of sports and recreation was restored – from that day some sports facilities were opened (Coronavirus stage 2, Regulation of the Council of Ministers of 2 May 2020 on the establishment of certain restrictions, orders and prohibitions in connection with the state of epidemic).
- May 18, 2020 – the process of lifting restrictions has begun. This was the penultimate stage of lifting coronavirus restrictions. As of Monday, May 18, 2020, the following social life regimes have been lifted:
  1. it is allowed to organize sports events for up to 50 people (events in the open space, without the participation of spectators),
  2. school classes in grades 1-3 (with a maximum number of children in the room),
  3. the number of believers allowed to stay in places of worship or other religious ceremonies was increased (there had to be 10 m^2 of free space per person instead of 15),
  4. in public transport the number of passengers has been increased to an equal number of seats in the vehicle.

  Regimes in the area of economic activity have been abolished:
  1. hairdressers and beauty salons were opened,
  2. shops in shopping malls have been opened – with a limit on the number of people allowed to stay in the store at one time,
  3. allowed to run stationary catering business (Coronavirus stage 3, Regulation of the Council of Ministers of 16 May 2020 on the establishment of certain restrictions, orders and prohibitions in connection with the state of epidemic).

- May 30, 2020 – on this day, the fourth stage of defrosting the economy began in Poland. During the fourth stage of defrosting the economy, the following rules were changed:
  1. the obligation to cover the mouth and nose in open spaces with a two-metre distance from others has been abolished. This obligation did not apply to parents with children and cohabitants, persons with disabilities. Covering the mouth and nose remained mandatory:
     - on public transport,
     - in stores,
     - in cinemas and theatres,
     - in tattoo and massage parlors,
     - in churches,
     - in offices (when dealing with matters),
     - at work (this requirement was not mandatory if the employer ensured adequate distances between workstations and met sanitary requirements),
     - in a restaurant or bar – until you take a seat at a table,
  2. the limit on people in the catering and retail industry has been lifted. Anyone could be in shops, post offices, markets, churches and places of worship (the obligation to cover the mouth and nose remained), during religious ceremonies and funerals, and in restaurants. However, in catering outlets, the appropriate distance between tables had to be maintained, and customers had to wear masks before sitting at the table,
  3. at that time, it was allowed to organize gatherings and open-air concerts in which up to 150 participants could take part, while maintaining a distance of 2 meters,
  4. hotels have fully reopened. It was also allowed to serve meals to guests in the hall in hotel restaurants and bars, and from 6 June hotel swimming pools, gyms and fitness clubs could reopen,
  5. from 6 June, weddings for up to 150 people were allowed. Also from 6 June, institutions such as:
     - cinemas, theatres, ballet and operas,
     - gyms, fitness clubs, playrooms, amusement parks and swimming pools,
     - tattoo and massage parlours, saunas and solariums,
  6. fairs, exhibitions and congresses were allowed (Coronavirus stage 4, Regulation of the Council of Ministers of 29 May 2020 on the establishment of certain restrictions, orders and prohibitions in connection with the state of epidemic).

It is worth mentioning that as of June 1, 2020, the ban on flights to and from airports located in EFTA (European Free Trade Agreement) member states and EU member states, with the exception of the Kingdom of Sweden, the Portuguese Republic and the Grand Duchy of Luxembourg, has been lifted. On 22 June 2022, rail traffic was restored within the internal borders of the European Union (Regulation of the Council of Ministers of 19 June 2020 on the establishment of certain restrictions, orders and prohibitions in connection with the state of epidemic).

The main objective of the article was to examine the impact of the COVID-19 pandemic on the functioning of passenger rail transport in Poland, to analyze transport preferences among passengers using passenger rail transport before and during the outbreak of the pandemic, and to examine assessments of the level of preparation of passenger carriers regarding the level of preparation and application of the introduced restrictions.

4. Study of the impact of the Covid-19 pandemic on the functioning of passenger rail transport in Poland

The COVID-19 pandemic and the restrictions introduced by the Polish government have somehow forced people in Poland and around the world to change their lifestyles and ways of working. The introduced restrictions have also forced a number of changes on rail carriers. These included, but were not limited to:

- mandatory wearing of masks,
- more frequent disinfection and cleaning of warehouses,
- limiting the number of passengers.

In order to examine how passengers perceive the impact of the COVID-19 pandemic on the functioning of passenger rail transport in Poland and how they assess the preparedness of rail carriers for the pandemic, an online survey was conducted on the Google Forms platform (https://www.google.pl/intl/pl/forms/about/). The survey was conducted among passengers using the services of the majority of carriers providing passenger rail transport in Polish. Thanks to the Google Forms platform and the ability to share the link to the survey in social media and send it by e-mail, a wider group of respondents could take part in the survey. The survey was anonymous and consisted of 11 questions. 366 respondents from sixteen provinces took part in the survey.

Figure 3 shows the gender breakdown of respondents.

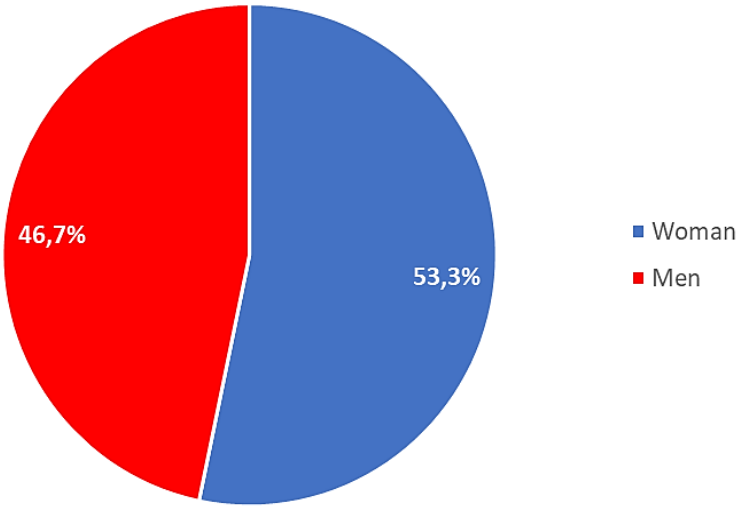


Figure 3. Gender breakdown of respondents.

Six age ranges were used to determine the age of the respondents: up to 18 years of age, from 18 to 25 years of age, from 26 to 40 years of age, from 41 to 50 years of age, from 51 to 60 years of age and over 60 years of age. The largest group of respondents – 115 (31.4%) people were aged 18 to 25, the second group were people aged 26 to 40 – 72 (19.7%) people, the third group were people aged 41 to 50, here 64 (17.5%) people completed the survey. On the other hand, 46 (12.6%) respondents were between 51 and 60 years old, and 42 (11.5%) were over 60 years old. The fewest surveys were completed by people under the age of 18. Only 27 (7.4%) respondents took the time to complete the survey. The largest number, i.e. 5 (18.52%) of people aged up to 18 years of age, came from the Zachodniopomorskie Voivodeship. In four voivodeships: Opolskie, Kujawsko-Pomorskie, Lubelskie and Świętokrzyskie, no one from this age group completed the survey. In the next group – from 18 to 25 years of age, the largest number of people – 56 (48.7%) – were from the Śląskie Voivodeship, and in the Łódź Voivodeship, no one completed the survey. In the next age group – from 26 to 40 years of age, the largest number 22 (30.56%) of questionnaires were completed by people from the Śląskie Voivodeship, while from five voivodeships: Kujawsko-Pomorskie, Lubelskie, Opolskie, Podkarpackie and Świętokrzyskie, 1 (1.39%) survey was received. In the next age group, i.e. from 41 to 50 years old, the largest number of questionnaires, i.e. 22 (34.38%) were completed by 76 inhabitants of the Śląskie Voivodeship, while in the Małopolskie Voivodeship, no one from this age group completed the survey. In the age group from 51 to 60 years old, the largest number 20 (43.48%) of questionnaires were completed by residents of the Śląskie Voivodeship. In three voivodships: Kuyavian-Pomeranian, Świętokrzyskie and Opole, no one filled out any questionnaire. In the last age group, i.e. over 60 years of age, the largest number of questionnaires, i.e. 8 (19.05%) was completed by residents of the Pomorskie Voivodeship, and in the following voivodeships: Kujawsko-Pomorskie, Świętokrzyskie, Opolskie and Podkarpackie no one completed any survey.

The second question in the survey concerned the education of the respondents. The respondents had a choice of the following answers: primary, vocational, secondary and tertiary. The largest number 173 (47.3%) of people declared secondary education. The second group – 115 (31.4%) – are people with higher education. 46 (12.6%) of the respondents had vocational education. Only 32 (8.7%) people declared primary education. The largest number of respondents with primary education were from the Śląskie and Zachodniopomorskie Voivodeships – 5 (15.63%) people each, in three voivodeships: Dolnośląskie, Opolskie and Świętokrzyskie, none of the respondents declared primary education. The largest number, i.e. 10 (21.74%) of people from the Śląskie Voivodeship declared vocational education. 1 (2.17%) of the survey – which is statistically the lowest – from people with vocational education came from the following voivodeships: Dolnośląskie, Łódzkie, Mazowieckie, Opolskie, Podkarpackie and Świętokrzyskie. As before, the largest number of people with secondary education was from the Śląskie Voivodeship – 62 (35.84%). None of the people from the Opolskie Voivodeship declared that they had secondary education. The largest number of people with higher education – 50 (43.48%) came from the Śląskie Voivodeship. On the other hand, no person from the Podkarpackie Voivodeship declared higher education. Figure 4 shows the breakdown of respondents participating in the survey according to their educational background.

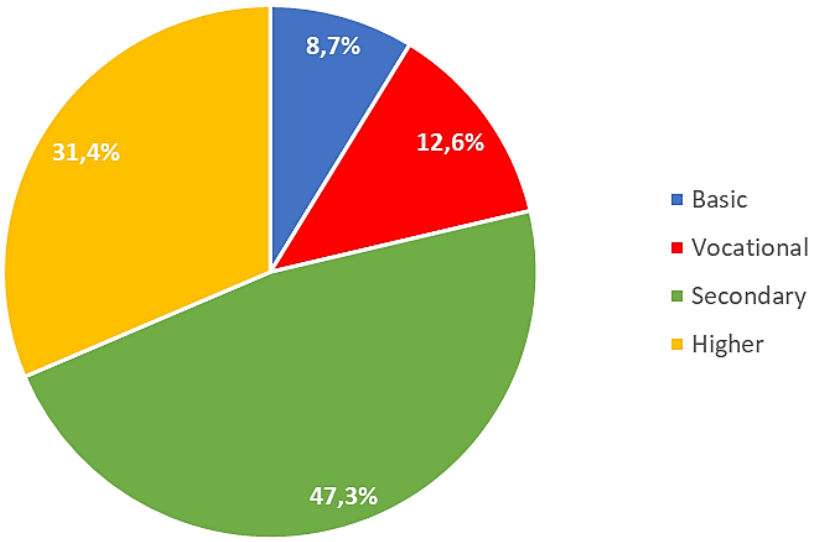


Figure 4. Distribution of respondents according to their education.

The next question in this part of the survey concerned the type of residence of the respondents. Here, the respondents had a choice between a village, a city of up to 50,000 inhabitants, a city of 51,000 to 100,000 inhabitants, and a city of more than 100,000 inhabitants. The largest number of surveys – 136 (37.2%) were completed by people living in cities with up to 50,000 inhabitants, rural residents completed 92 (25%) surveys and became the second most active participants in terms of the type of place of residence. Other respondents declared that they live in cities with more than 100,000 inhabitants and completed 79 (21.6) questionnaires. The fewest surveys, i.e. 59 (16.1%), were completed by bourgeois cities with a population of 51,000 to 100,000. Among the inhabitants of rural areas, the largest number (32 (34.78%) of

the questionnaires were completed by the inhabitants of the Śląskie Voivodeship, the fewest (1.09%) were completed by a resident of the Lubelskie Voivodeship. Among the respondents living in a city of up to 50,000 inhabitants, the largest number of surveys, 45 (33.09%), was completed by residents of the Śląskie Voivodeship. Not a single survey of a person living in a city of up to 50,000 was received from the Świętokrzyskie Voivodeship. In the next group, i.e. among the inhabitants of cities with 51 to 100 thousand, the largest number of surveys, i.e. 17 (28.81), were again completed by the inhabitants of the Śląskie Voivodeship. No survey was received from the inhabitants of cities in this area, living in the following voivodeships: Lubelskie, Łódzkie, Małopolskie, Opolskie and Świętokrzyskie. In the last group, i.e. among people living in cities with more than 100,000 inhabitants, the largest number of surveys, 32 (34.78%), were received from residents of the Śląskie Voivodeship. Residents of the Dolnośląskie and Lubelskie Voivodeships, living in the largest cities, completed the fewest, i.e. 1 (1.09%) survey. Figure 5 shows the breakdown of respondents by place of residence.

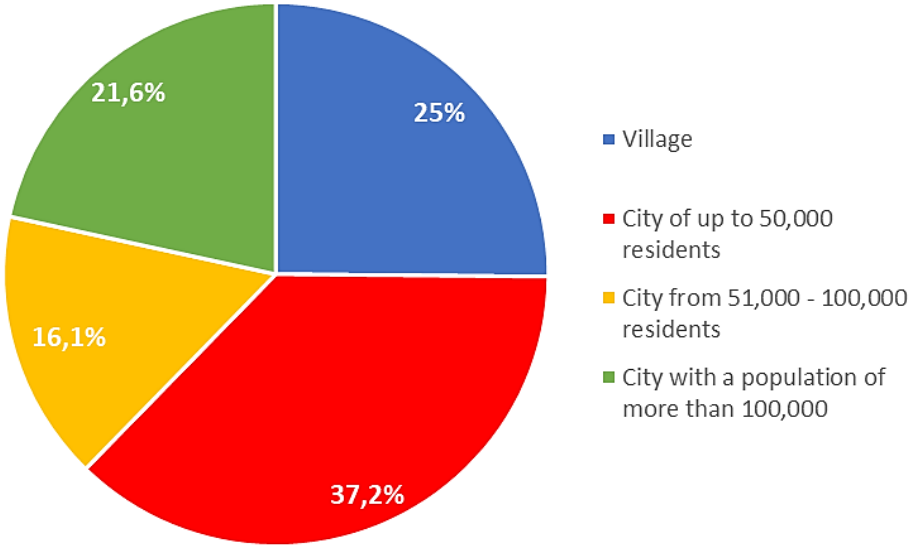


Figure 5. Breakdown of respondents by place of residence.

The next question was to answer what is the purpose of the respondents' trip. Respondents could choose from the following answers: "Commuting to work", "Commuting to school", "Commuting to universities", "Business trip", "Holiday trips" and the option to enter other travel destinations. Respondents gave 522 answers about their travel destinations. 70 (13.41%) of them were marked as "Other". Among others, the respondents indicated: commuting to the city – 13 people, visiting family – 12 people, commuting to the employment office – 10 people, going to the doctor – 9 people, getting to the family home – 7 people, visiting the country and recreational trips – 6 people, visiting friends – 4 people and 3 people entered private trips. Out of all the possible choices, the largest number of people, 145 (27.78%) chose "Commuting to work". Another reason was "Holiday travel", chosen by 134 (25.67%) people. For 76 (14.56%) people, the reason was "Business trips". For 67 (12.84%) of the respondents, the main reason for using it was "Commuting to universities", and for 30 (5.75%) "Commuting to school". Figure 6 shows the breakdown of the number of votes for each destination.

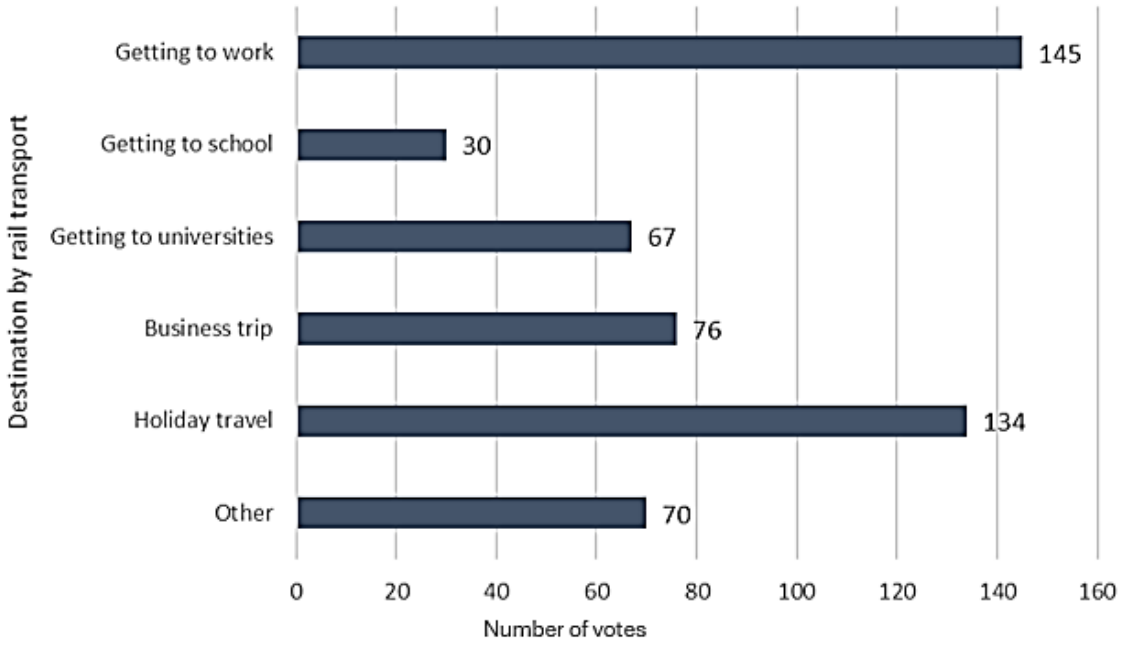


Figure 6. Distribution of votes for different destinations by rail.

The next question in the survey was to determine what discouraged respondents from using rail transport the most during the coronavirus pandemic. Respondents had a choice of the following answers: "Fear of infection", "Lack of availability of seats", "Failure to respect the obligation to cover the mouth and nose", "Mandatory wearing of protective masks", "Inability to disinfect hands", "Infrequent disinfection of rolling stock". In addition, respondents could enter restrictions in "Other". A total of 703 answers were given to the question asked. The fewest, 40 (5.69%), were individual entries of the respondents. The most popular of them was the post "Nothing discouraged". Out of 40 people, 35 (87.5%) made such an entry. Of the proposed answers, the answer "Lack of availability of seats" received the highest number of votes, 153 (21.76%). "Fear of infection" was chosen by 111 (15.79%) people. On the other hand, the answer "Not respecting the obligation to cover the mouth and nose" was chosen by 108 (15.36%) of the respondents, and the answer "Obligation to wear protective masks" was selected by 106 (15.08%) people. For 95 (13.51%) people, the cleanliness of the trains was a problem, so they chose the answer "Rare disinfection of rolling stock". On the other hand, the answer "No possibility to disinfect hands" was chosen by 90 (12.80%) of respondents. Figure 7 shows the answers to the question of what discouraged respondents from using rail transport during the pandemic.

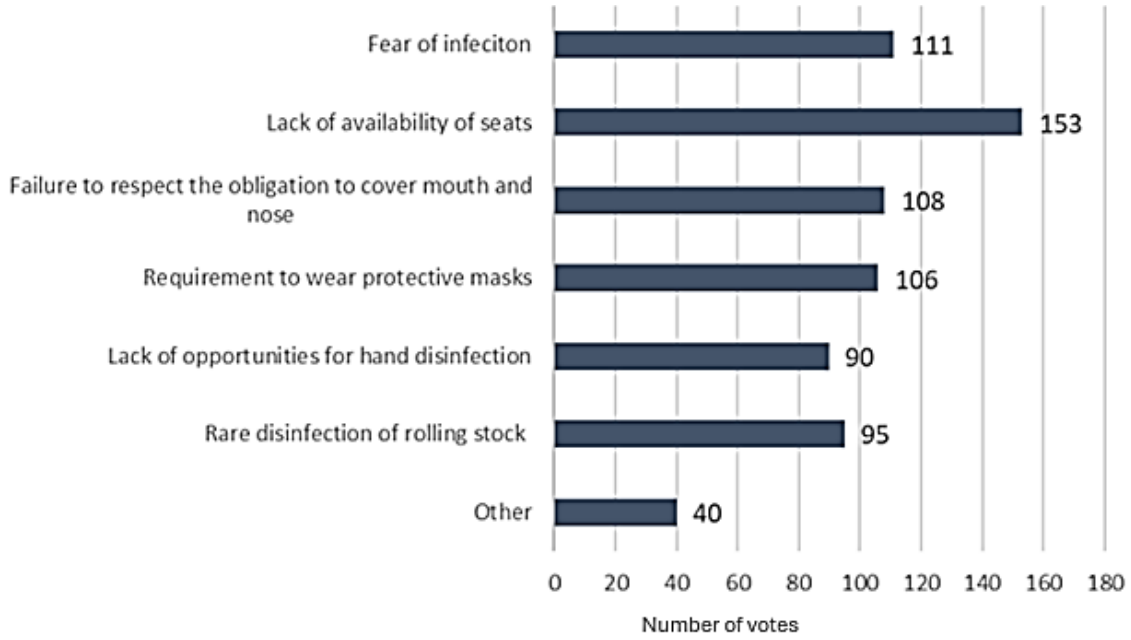


Figure 7. What discouraged respondents from using rail transport during the pandemic.

The sixth question concerned the assessment of the availability of disinfectants at passenger service points. As in the fifth question, a rating of '5' indicates a 'very high' availability of supplies, while a rating of '1' indicates the absence of disinfectants at passenger service points. In this question, the "3" rating received the most votes, this rating was chosen by 130 (35.52%) respondents. The second grade "4" received votes from 100 (27.32%) of the respondents. The third place is "1", which was chosen by 51 (13.93%), and the fourth "5" received 44 (12.02%) votes. The last grade, i.e. "2", received 41 (11.20%). Figure 8 shows the respondents' assessment of the availability of disinfectants at passenger service points.

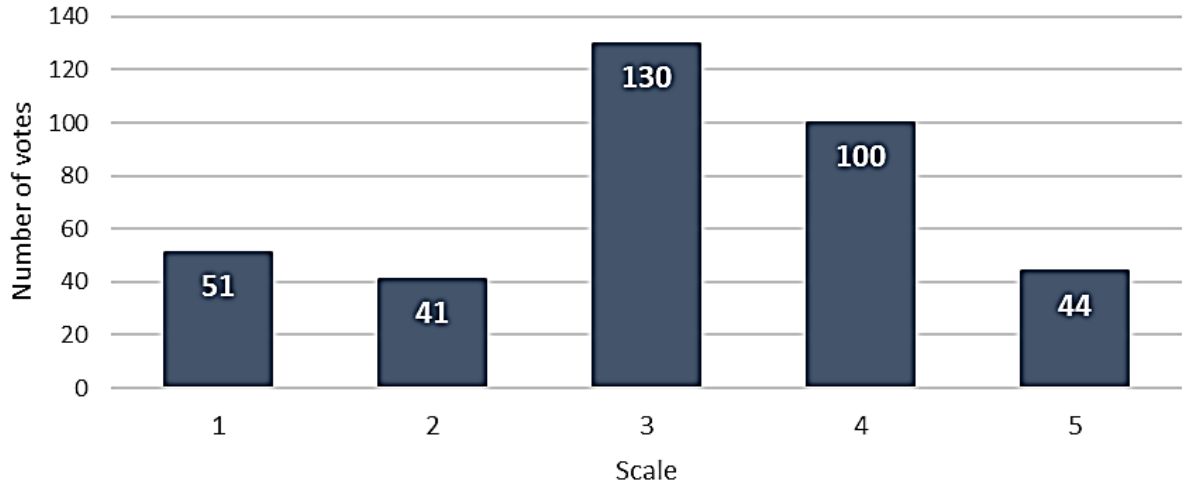


Figure 8. Assessment of the availability of disinfectants at passenger service points.

The next question concerned the assessment of the transmission of information and basic safety rules by means of information carriers in rolling stock during the pandemic. In the case of this question, a rating of "5" indicates that the information is very well conveyed, while a rating of "1" indicates no information. In the case of this assessment, "4" received the most votes, marked by 154 (42.08%) of respondents. The second is the "3" rating, chosen by 100 (27.32%) people. The third highest rating was "5" by 79 (21.58%) people. The fourth grade "2" was chosen by 25 (6.83%) of respondents. The fewest respondents chose the "1" rating, 8 (2.19%) of respondents did so. Figure 9 shows the respondents' assessment of the information provided and the basic safety rules implemented during the pandemic with the use of information media in rail transport.

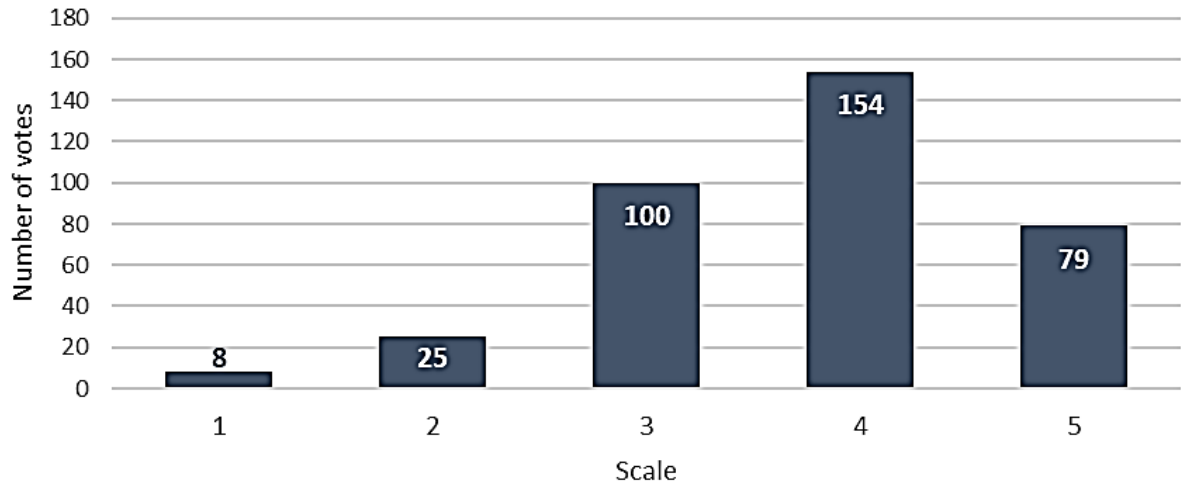


Figure 9. Evaluation of the information provided and safety rules on information carriers in rail transport.

The eighth question concerned the safety of rail travel during the Covid-19 pandemic. For this question, a rating of "5" is the highest grade and a rating of "1" is the lowest degree of safety. In the case of this question, the highest number of votes was received by the "3" rating, which was chosen by 128 (34.97%) people. The second in line was a grade of "4". It was chosen by 109 (29.78%) of respondents. The third "2" received 62 (16.94%) votes from the respondents. The "5" rating is fourth in the ranking, with 44 (12.02%) votes. The lowest number of votes was received by the "1" rating, for which 23 (6.28%) votes were cast. Figure 10 shows the assessment of the safety of rail travel during the pandemic.

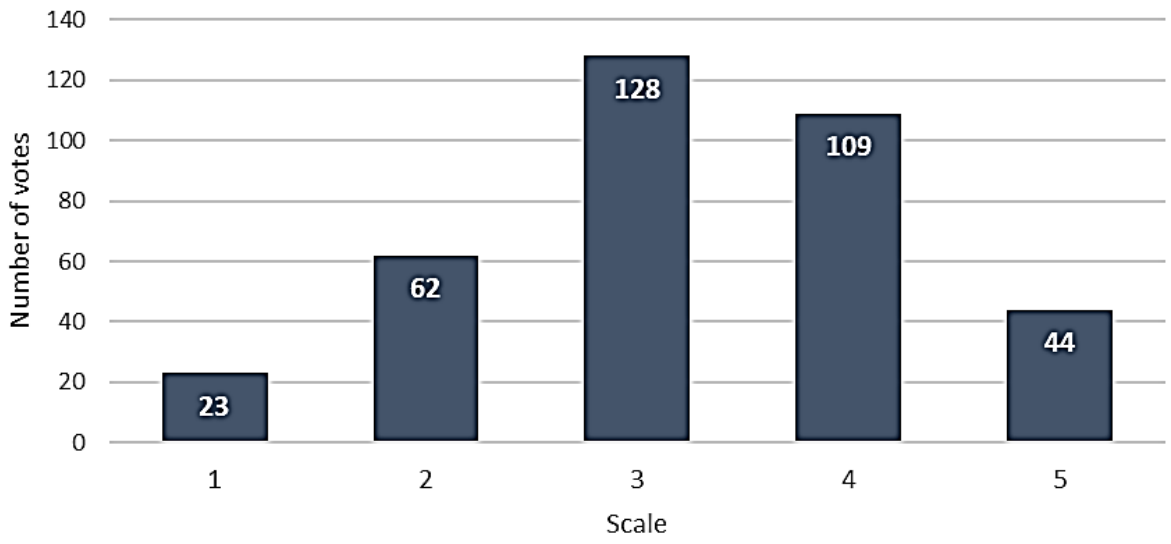


Figure 10. What discouraged respondents from using rail transport during the pandemic.

The next questions had only two answers – "YES" and "NO". One of the questions concerned whether respondents declared their resignation from rail transport during the Covid-19 pandemic. For this question, 259 (70.8%) of respondents chose "NO" and 107 (29.2%) of respondents chose "YES". The second question could only be answered if you selected "NO" in the previous question. The second question concerned the respondents' declaration of a return to using rail transport after the lifting of pandemic-related restrictions. In this question, 87 (81.3%) respondents chose the answer 'YES' and 20 (18.7%) chose the answer 'NO'. Figure 11 shows the percentage of responses from individuals, while Figure 12 shows the percentage distribution of people declaring a return to rail transport.

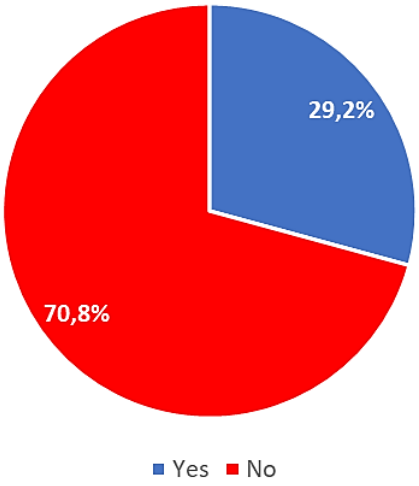


Figure 11. Percentage distribution of declarations regarding the abandonment of rail transport.

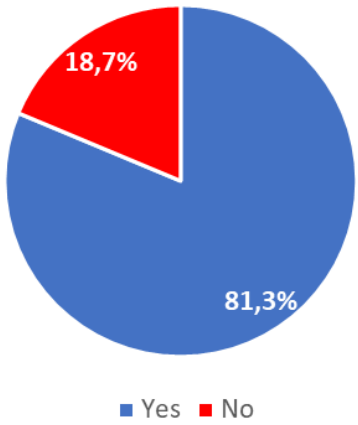


Figure 12. Percentage distribution of declarations regarding the return to rail transport after the lifting of pandemic-related restrictions.

The last question concerned the respondents' assessment of the impact of the Covid-19 pandemic on the functioning of rail transport in Poland. In this question, a score of "5" indicated that the pandemic had a very high impact, while a rating of "1" indicated that the impact on transport was very low. In the case of this question, 121 (33.06%) of respondents considered that the pandemic had a very large impact on the functioning of rail transport and chose a rating of "5". As many as 101 (27.60%) respondents chose a "4" rating, and 96 (26.23%) considered that the pandemic had a moderate impact and chose a "3" rating. The "2" rating was chosen by 27 (7.38%) of respondents. On the other hand, 21 (5.74%) respondents chose a rating of "1", thus recognizing that the pandemic had very little impact on the operation of the railways. Figure 13 shows an assessment of the impact of the COVID-19 pandemic on rail transport operations.

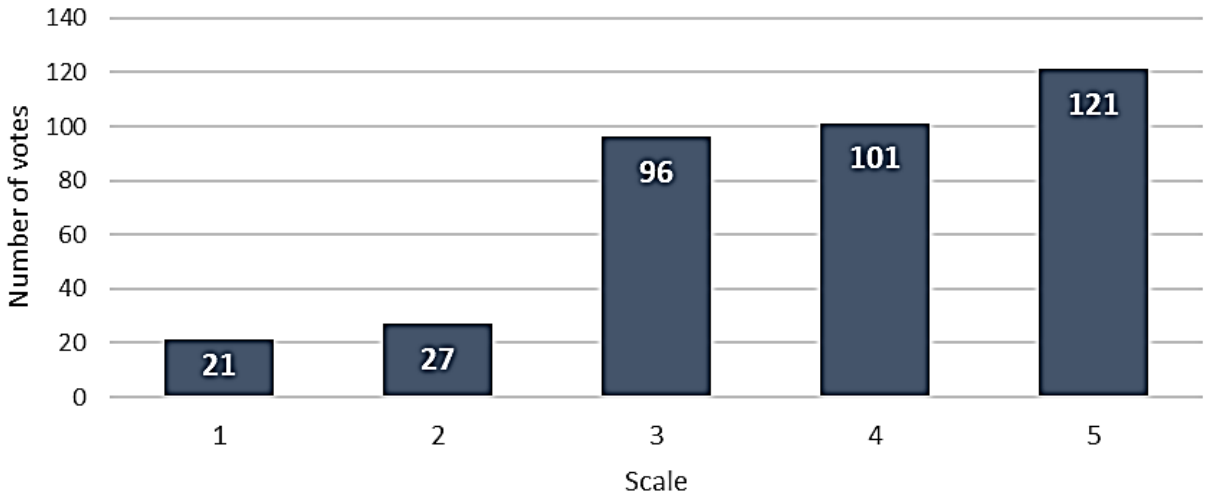


Figure 13. The impact of the Covid-19 pandemic on the functioning of rail transport.

5. Discussion

The COVID-19 pandemic has had a profound impact on various economic sectors globally, and one of the most affected areas has been passenger transport. This article reveals several key aspects of the pandemic's effects on passenger rail transport in Poland. The survey data provides valuable insights into passenger preferences, carrier preparedness, and the general perception of the measures implemented during this unprecedented period.

The survey results indicate a significant adjustment in travel habits among passengers in response to the pandemic. A marked decline in travel frequency was observed, with many individuals opting for remote work or refraining from non-essential trips. This aligns with findings from other studies indicating that pandemics can drastically alter travel behavior, leading to long-term changes in transportation patterns (Burdzik, 2021). Despite these changes, rail transport emerged as the preferred mode for those who needed to travel, showcasing a degree of resilience in this sector. This preference for rail transport during the pandemic can be attributed to the effective implementation of health and safety measures by carriers, which reassured passengers about the relative safety of train travel compared to other public transport modes. Research conducted by Davalbhakta et al. (2020) supports this notion, emphasizing that perceived safety is critical in influencing transport choices during health crises.

A significant finding of this study is the positive assessment of carrier preparedness by passengers. The majority of respondents expressed satisfaction with the actions taken by rail carriers to ensure passenger safety. Measures such as increased cleaning frequency, availability of disinfectants, enforcement of mask-wearing, and clear communication regarding safety protocols received high ratings. This positive feedback highlights the importance of proactive and transparent actions in maintaining passenger confidence and ensuring continued use of rail services during health crises. Previous research by Cartenì et al. (2021) also notes that transparency and effective communication are crucial for maintaining public trust in transport systems during emergencies.

To enhance the resilience of railway transportation systems during pandemics, several strategies are pivotal. Firstly, integrating robust decision-making frameworks allows for agile adjustments to operations amid evolving pandemic impacts (Jenelius, 2022). Furthermore, adopting a comprehensive resilience framework that accounts for supply shocks and demand fluctuations enables railways to sustain operations efficiently (Schofer et al., 2022). These measures are complemented by technological advancements for real-time monitoring and predictive maintenance, ensuring operational continuity and reliability (Tardivo et al., 2021). Moreover, optimizing resource allocation, such as strategically positioning relief trains, enhances response capabilities during disruptions (Xiao et al., 2022). Collaborative efforts among stakeholders further strengthen resilience by facilitating resource sharing and

coordinated response strategies. Research by Jenelius and Mattsson (2022) emphasizes the importance of stakeholder collaboration in enhancing system resilience. Together, these strategies bolster the ability of railway systems to navigate challenges posed by pandemics and maintain essential transport services. The schematic plan of managerial insights is demonstrated in Figure 14.

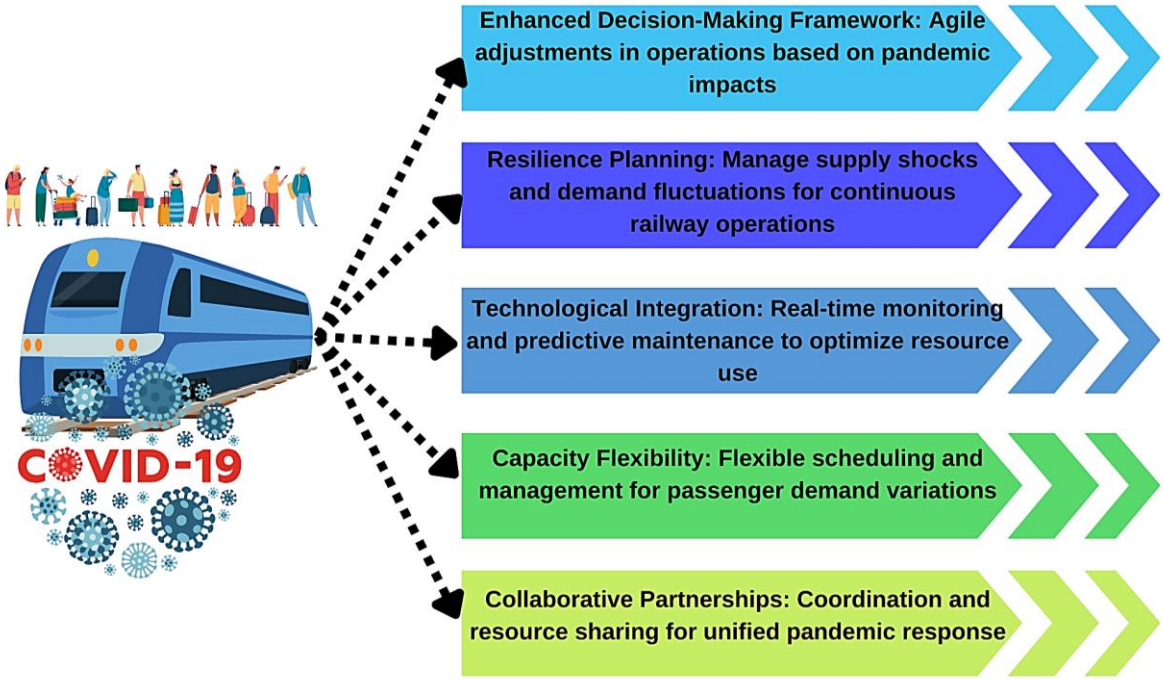


Figure 14. The schematic plan of managerial insights in the present research.

The research indicates that the rail passenger transport sector in Poland has demonstrated a significant ability to adapt and respond to the COVID-19 pandemic. However, there is a pressing need for further investment in health and safety infrastructure, staff training, and better communication with passengers to ensure resilience against future disruptions. In line with the findings of this study, it is recommended to develop contingency plans for various crisis scenarios, drawing upon insights from studies that advocate for scenario planning in transport systems (Burdzik, 2023; Cartenì et al., 2021). Additionally, effective and transparent communication with passengers is crucial for building trust in rail transport, as emphasized by the American Public Transportation Association (2021), which underscores the need for consistent messaging during crises.

Regular research and analysis of passenger preferences and the effectiveness of implemented security measures are essential to adapt operational strategies to current challenges. Research conducted by Chen et al. (2021) highlights the importance of continuous evaluation and adaptation in transport systems to address shifting passenger needs during and post-pandemic.

In summary, the COVID-19 pandemic has catalyzed significant transformations in the passenger rail transport sector in Poland. While the sector has shown resilience, ongoing efforts in infrastructure investment, staff training, and stakeholder collaboration are vital to preparing for future challenges.

6. Conclusions

To sum up, the COVID-19 pandemic has forced passenger rail transport in Poland to make a number of adaptations and introduce new standards aimed at increasing passenger safety and adapting the offer to the changing conditions and needs of travelers.

The following conclusions can be drawn from the survey:

- the largest number of respondents use the train as a means of transport to get to work, for whom the price of the service and safety during the journey is very important,
- regardless of the voivodship in which the respondents lived, 77% of respondents did not change their attitude towards the choice of means of transport,
- before the pandemic, the largest number of people using the survey used rail transport several times a week, during the pandemic the frequency changed to several times a month, and after most restrictions were lifted, the frequency returned to the level of several times a week,
- as a result of the outbreak of the pandemic, a significant number of people who had previously used rail transport 'switched' to private cars. This is due to the fact that some respondents were afraid of contracting the virus in rail transport. Another factor was the lack of adequate seating,
- the respondents assessed the general preparedness of rail transport for the pandemic and the activities aimed at informing about the situation and basic safety rules presented on the information carriers installed in the rolling stock relatively well,
- according to respondents, the Covid-19 pandemic has had a very large impact on the functioning of rail transport in Poland by reducing revenues, which was the result of a reduction in the number of passengers transported.

The results of the survey on the improvement of the quality of rail travel, whether during the pandemic or after its end, may be an important indication for rail carriers and provincial authorities as to how passengers use rail transport and what are the expectations towards it.

To sum up, the COVID-19 pandemic has created serious challenges for passenger rail transport in Poland, but has also become an impetus for many positive changes and innovations that can contribute to the long-term development and resilience of the sector.

Acknowledgements

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