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THE IMPACT OF THE PANDEMIC ON THE DAILY MOBILITY OF RESIDENTS

Abstract. The COVID 19 pandemic has created blocks in our society that have affected all areas of our lives. One of the areas that have been affected most significantly is the transport sector. Due to the restrictions against the spread of the pandemic, public transport suffered huge losses. The aim of this contribution is to point out the changes in the traffic behavior of the inhabitants of Slovakia due to the COVID-19 pandemic. For this purpose, the data obtained using a questionnaire survey, which was carried out during 2021 by the inhabitants of Slovakia, served this purpose. It was found that during the strongest waves of the pandemic, residents avoided using public transport and switched to other modes of transport, primarily individual car and pedestrian transport. The main reason was safety and health concerns.
Keywords: Pandemic, mobility, means of transport.

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Introduction

Common diseases rarely occur in all countries at the same time. Currently, the world is facing a new common crisis of COVID-19, which has spread rapidly from China since mid-December 2019. From the beginning of January to the end of February 2020, a total of 54 countries were affected. On January 30, 2020, the World Health Organization (WHO) declared the disease outbreak an international public health crisis. Isolating people from face-to-face meetings as much as possible has proven to be the most effective way to deal with this problem. In Slovakia, the first case of infection occurred at the beginning of March 2020 (WHO, 2021). The COVID-19 pandemic has caused 620 million confirmed cases and 6.55 million deaths worldwide since its inception on 5 October 2022 (WHO, 2022). The outbreak of the COVID-19 pandemic showed that in times of higher risk of contagion, people expressed fear for safety when using public transport. The paper points to changes in mobility, especially travel, in research that has been done around the world. It presents a small but very important insight into an aspect of everyday life and everyday mobility and focuses on public transport users. It describes the process of development and overview of the spread of the pandemic, the measures taken and the impact on the use of public transport in Slovakia. Subsequently, the methodology and results of the research and the conclusion are presented. The aim is to find out the effects of the pandemic on the use of public transport when subjective attitudes and personal safety have become the main factor in choosing a mode of transport.

The COVID-19 pandemic has changed people's behavior in transport. During the first wave of the pandemic in the spring of 2020, public transport almost completely stopped, and at the same time individual transport saw a significant increase. With the rapid spread of the COVID-19 pandemic, efforts to collect new data have increased. Therefore, international sources started to publish data on mobility because of the importance of mobility. Accordingly, the use of mobility data has become of interest in studying the impact of the COVID-19 pandemic. Since the outbreak of the threat of COVID-19 and restrictions on human interactions, a large decrease in mobility has been observed worldwide. During the COVID-19 crisis, the European Commission asked some companies such as Google, Apple to publish real-time daily data on people's mobility in order to study human movement trends. Meanwhile, real-time mobility data has helped clarify the transmission of COVID-19 and ensure the implementation of strict control measures that have substantially mitigated the spread of COVID-19.

All social events were banned, work and school moved into the home. Such measures caused a reduction in public transport passengers, which represented a huge drop in revenue for transport companies. Of course, the decrease in the number of passengers in public transport was probably caused by restrictions, but also by the

passengers' own decisions. Stations and means of public transport were considered a high-risk environment for the transmission of COVID-19. But on the other hand, the number of vehicles on the road also decreased, which was shown in a positive light in terms of the decrease in emissions. Overall, the pandemic had a huge impact on mobility changes, such as a decrease in shared mobility or increased private mobility (Pawar et al., 2020).

Several studies have used human mobility data to analyze emerging travel activities and travel behavior in China during the pandemic. The results show that the strict control measures implemented by the government have significantly mitigated the spread of COVID-19 and the share of travel activities has significantly decreased. In addition, there was a shift of people from public transport to walking and the use of private transport, preferring "zero-contact" modes of transport (Abdullah et al., 2021). Similar travel models were also addressed in European countries, where the number of passengers significantly decreased in the case of rail and bus transport. Based on movement data, the researchers found that more than half of the world's population reduced travel by more than 50 percent in April 2020. Public transport systems have lost a dramatic number of passengers. (McKinsey Center for Future Mobility, 2022) reported 70 to 90 percent fewer travelers. Although the cities kept public transport running, they had to reduce the frequency of services and connections to reduce costs. (Konečný et al., 2021; Czódörová et al., 2021).

1. Public transport in Slovakia

The transport sector is particularly affected by the current situation regarding the coronavirus. In addition, the use of public transport is believed to play a critical role in the transmission of the virus. Additionally, monitoring human mobility and migration data can be used to understand and predict the spread of COVID-19. It is understandable that in any period of higher risk of infection (ie seasonal flu), let alone a pandemic, people feel less confident about their health. Existing research does not show whether mass transit systems should be closed during a pandemic. There is always a risk of influenza transmission in public transport systems and it is indisputable that social distancing measures have clear, direct positive effects on health as they are implemented to help people avoid infection (Hadjidemetriou et al., 2020).

An overview of the development of transported persons in passenger transport in Slovakia is presented in the following images. Since complete data for the year 20221 are not yet available, only values from 2010 to 2021 were compared (Statistical Office of the Slovak Republic, 2021).

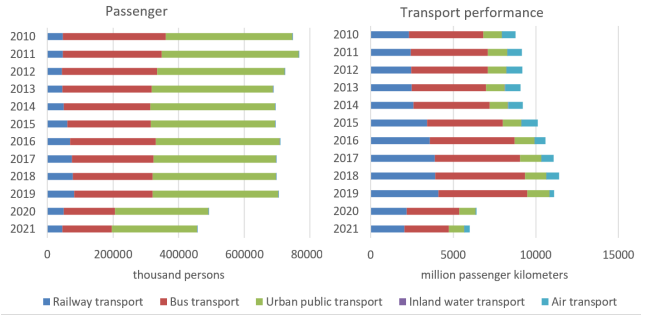


Fig. 1. Transportation of people (without passenger cars) and performances in the monitored years 2010-2020 (Source: author according to the Statistical Office of the Slovak)

As can be seen from Fig. 1, in 2020 (due to the pandemic) there was a significant decrease in the number of transported persons in public passenger transport compared to previous years. The largest decrease in the number of passengers was recorded in March 2020. In previous years, the number of transported persons was at the level of 700,000 thousand. persons. However, due to the pandemic, the number decreased by almost 30%, but the most in rail transport (39%), followed by road transport (35%). In terms of passenger kilometers, the decrease reached 42% compared to the previous year 2019. The decrease was caused by the reduced mobility of residents. One of the main factors in the departure of passengers from public transport was the fear of transmission of the virus causing the disease COVID-19, but also the transfer of people from public transport to private, or individual. The reaction of passengers and the imposed restrictions therefore had a similar impact in Slovakia as in other countries described in other researches. In addition to the pandemic, human mobility is also affected by seasonal fluctuations during the year, e.g. such as vacations, vacations but also weather fluctuations. In 2021, traffic volumes did not even reach the values of 2020.

2. Measures and mobility in Slovakia

The COVID-19 pandemic, which was first defined in the 10th calendar week of 2020, caused a total of 2.63 million cases and 20,467 deaths in Slovakia as of 9/30/2022 (Ministry of Health of the Slovak Republic, 2022). In addition, some precautionary measures such as mobility and transport restrictions have been put in place to keep the pandemic under control and preserve public health.

Year 2020

• In February, the airports in Bratislava, Košice and Poprad introduced a full-scale check of passengers by measuring their body temperature.

• In March, border controls were launched and all international flights were cancelled,

o all kindergartens, primary and secondary schools and universities were closed,

o, based on the measures taken by the Public Health Office, they had to start wearing face masks

outside their residences and there should be a minimum distance of 2 meters in rows.

• Measures were relaxed during April and May. Residents of Slovakia can now cross the border and do not have to undergo state quarantine as long as they return within 24 hours.

• In August, the Ministry of Health published a pandemic plan, which describes the procedure of individual components of the state in the event of a pandemic.

• In September, a new record was set in the daily increase of infected people, when the number of new cases exceeded 300 for the first time.

• On October 1, a state of emergency was declared for a period of 45 days in the entire territory of Slovakia. At the same time, new travel measures came into force,

o apply a curfew on the entire territory of Slovakia, with the exception of traveling to work, for testing and securing essential needs or staying in nature in the district of residence.

• In November, the state of emergency from October 1 was extended by another 45 days.

• In the second half of December, a curfew began to apply in Slovakia, with several exceptions, during the Christmas holidays,

o at the end of the month, the government extended the state of emergency by 40 days in an online negotiation.

Year 2021

• Stricter measures came into force in January and remained in effect until January.

• At the beginning of February, the government approved the tightening of the covid machine, which entered into force on February 8, and the extension of the state of emergency by another 40 days.

• On April 22, 2020, a higher limit for contactless payment by card without entering a PIN code came into effect from €20 to €50.

• Measures were relaxed in the summer months.

• A state of emergency has been in effect since November 25, 2021, which was canceled on February 23, 2022.

Therefore, it will be useful to understand the effects of mobility as a representative of citizens' transport activities on the spread of COVID-19 (expressed by the number of patients and deaths) in Slovakia. Such an analysis can assist regulatory authorities in deciding whether to maintain, reduce or end mobility restrictions. This is important because such restrictions have a negative impact on economic development, especially in terms of employment and welfare.

Mobility in Google

These reports show how traffic and length of stay at different locations are changing compared to baseline. These changes are calculated using the same type of aggregated and anonymized data used to display popular times for places on Google Maps. Changes for each day are compared to the baseline for the corresponding day of the week. The baseline value is the mean value for the respective day of the week during the 5-week period from 3 January to 6 February 2020 (Google -mobility, 2022).

The types of data that are included in the calculation depend on user settings, connectivity options and whether they meet our privacy standard.

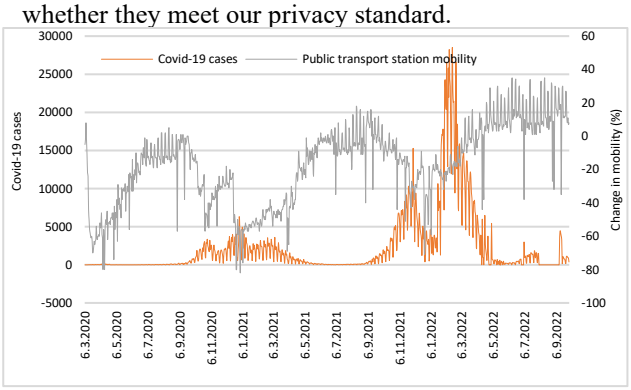


Fig. 2. Mobility of people at Google public transport stations in Slovakia (Source: author according to Google)

In Fig. 2 shows the daily movement of the population at public transport stations and the number of cases at the time of the pandemic. The mobility of Google users has had an up and down trend over time. In addition, mobility has changed over time due to measures and cases that have affected citizens' mobility abilities. The highest changes were achieved in the summer months, which can be caused on the one hand by the holiday season. On the other hand, in the summer months minimal measures were in force in connection with the spread of the virus. Outside the pandemic waves, mobility gradually increased However, mobility decreased the most within public transport stations during the first two waves of the pandemic by 50% and 42%.

Graphs of the dependence between the number of positive cases and the change in mobility in public transport are shown in the figure below.

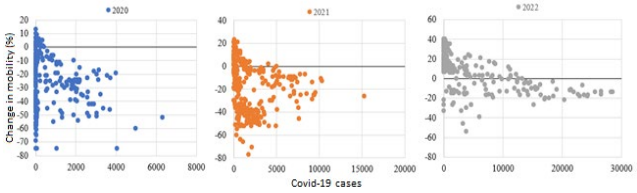


Fig. 3. Graph of dependence between public transport stations and positive cases (Source: author)

As can be seen from Fig. 3, in 2020 the mobility of residents decreased the most of all monitored years, although the fewest positive cases were identified. On average, its value for 2020 decreased by 24.2%, in 2021 it decreased by more than 16%. On the other hand, in 2022, despite the highest number of confirmed cases, mobility was restricted the least and its average value even increased by an average of 7%. Travel restrictions have significantly affected people's movement behavior, and at the same time, people pay more attention to the feeling of safety and health. It is assumed that the perception of personal safety has a significant impact on the number of passengers in public transport (Fatmi, 2020).

3. Research method

The data was collected through an online questionnaire from June 8, 2021 to November 8, 2021 (a total of five months). This tool is acceptable in view of anti-pandemic measures and social isolation. The survey was carried out in cooperation with the University of Žilina in Žilina and the people of Slovakia. The timing of data collection was at the edge of mitigation measures. When respondents were expected to remember changes in travel habits brought about by policy measures. At the same time, there was a relaxation of measures in the first wave of the COVID-19 pandemic in 2020. However, in this case, the closure of the country represented a greater shock and silence for the population, as there was only a minimal amount of information about the COVID-19 virus. The questionnaire questions focus only on the daily travel of residents, as the measures taken led to a decrease in long-distance trips. In general, travel during the week is more structured due to work and school. Individuals travel less during the weekend. Therefore, when analyzing daily mobility, we focus on working days.

Questionnaire survey

All the mentioned questions were focused on weekly activities and the intensity of traveling to work, shopping, using different types of means of transport during the day.

The questionnaire also included sociodemographic factors such as age, gender, occupation, education, place of residence.

The main goal of the questionnaire was to capture changes in mobility and in people's behavior patterns when choosing a route. The following table describes the number of respondents involved in the survey.

Table 1. Sample of respondents (Source: author)

Gender			***Status***						
			Student	**Businessman**	**Employee**	**Unemployed**	**Retiree**	**Other**	**Total**
Male	Education	Basic education	3	0	0	0	0	0	3
		Secondary education	18	2	12	0	0	0	32
		University education	26	4	120	0	5	3	158
		No reply	1	0	0	0	0	0	1
	Total		49	6	133	0	5	3	196
Female	Education	Basic education	5	0	0	0	0	0	5
		Secondary education	8	0	24	2	5	0	39
		University education	22	6	135	1	5	0	169
	Total		35	6	160	3	10	0	214

As can be seen in tab. 1, the sample consists of more than half of women (more than 52% of all). It is obvious that the largest subset consists of employees with university education (327 respondents, almost 63% of all), other employees regardless of gender have secondary education. More than 27% of respondents are aged 26-35, which is the largest group.

4. Research results

The main reason why respondents traveled less by public transport was remote work, which limited daily mobility. The results of the survey conducted show that since the outbreak of the pandemic, 32% of respondents have changed their decisions regarding the choice of means of transport for daily travel (Fig. 4).

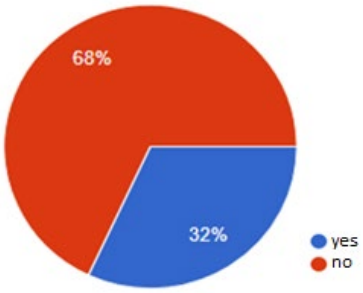


Fig. 4. Have you changed your decisions regarding the choice of means of transport for daily travel since the outbreak of the pandemic? (Source: author)

And those who traveled for daily activities by public transport switched to individual transport. The change in the professional situation after the outbreak of the pandemic is shown in Fig. 5.

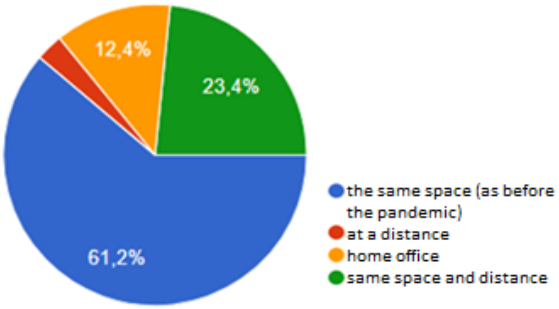


Fig. 5. Change of professional situation (Source: author)

Of course, the use of public transport also depends on the change in the place of the respondents' daily activity. The respondents were also asked to rate (on a scale from 1 to 5, where 1 means the least and 5 means the most frequently used mode of public transport) the use of public transport (Fig. 6).

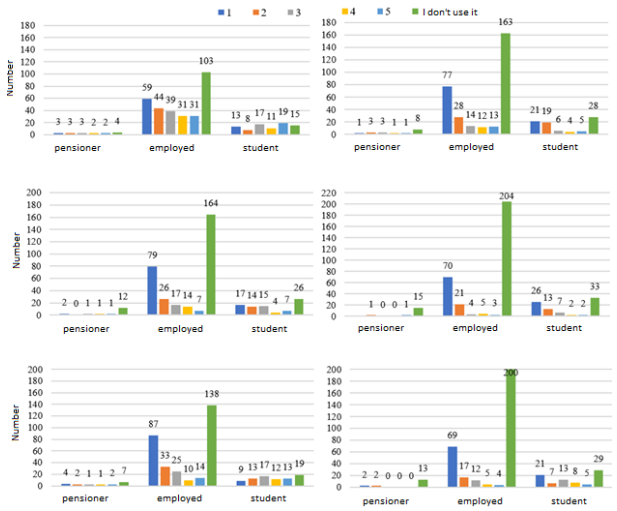


Fig. 6. Use of public transport in terms of respondents' economic status (Source: author)

According to the economic status of the respondents, it was found that they most limited the use of public transport for employment. Most respondents report that they have changed their use of public transport - almost 65% say they have changed their use of public transport and 30% have stopped using public transport.

A significant decrease in the number of passengers caused changes in these services, but on the other hand, with the return of economic activity, the demand for mobility began to grow.

Changes in the choice of transport depending on the frequency are shown in Fig. 7.



Fig. 7. Changes in the use of means of transport before and during the COVID-19 pandemic (Source: author)

As can be seen, the respondents prefer individual car transport over other types of transport. Of course, these results mainly concern private vehicles as opposed to shared space. However, many respondents prefer a healthy lifestyle, as walking is also a preferred form of exercise. On the other hand, less than 10 respondents prefer private bike and shared bike.

Research results show that car transport and walking are even more preferred modes of transport during the pandemic. We found that more than 250 respondents chose the car as their most preferred mode of transport (up more than 22% from 205 to 251) and more than 180 respondents chose walking (up 19% from 153 to 182). On the other hand, we find that the population does not prefer public transport such as urban public transport, suburban transport or railway transport. Regardless of the pandemic situation, public transport, including public transport, suburban transport and rail transport, is one of the least preferred modes of transport.

However, the results show that the respondents prefer public transport even less compared to the previous period. There is a dramatic decrease in all these types of transport, for example urban transport (down by more than 63% from 52 to 19 respondents), suburban transport (down by 60% from 15 to 6 passengers), passenger rail transport (down by almost 70% from 29 to 9 respondents).

Table 2. Changing the frequency of use of the selected transport (Source: author)

Mean of transport	Never	1x per week	2-3x per week	4-5x per week	Every day
Car	-3,90	-2,93	-0,73	-3,66	11,22
Public transport	24,88	-1,22	-9,02	-6,59	-8,05
Bus	11,71	-1,22	-5,37	-2,93	-2,20
Train	17,07	-5,37	-4,39	-2,44	-4,88
Wolking	1,71	-3,41	-7,80	2,44	7,07
Private bike	0,98	-2,93	-1,22	-1,22	4,39
Public bike	8,54	-4,63	-2,68	-1,95	0,73

That is, respondents who used public transport on a daily basis, or more times a week, reduced their use or switched to another mode of transport. In the case of a passenger car, the frequency of use every day increased by 11% and the possibility of non-use decreased by almost 4%. A daily increase was also noted in the use of a bicycle and walking.

The above data show a big difference between the use of public and individual transport during and before the pandemic in the group of public transport users. This is confirmed by the global trend in the decrease in the use of public transport during the pandemic and the increase in the use of individual passenger cars. However, it also sees a daily increase in the use of private bicycles, although public bicycles have seen a decline in use of more than 8%.

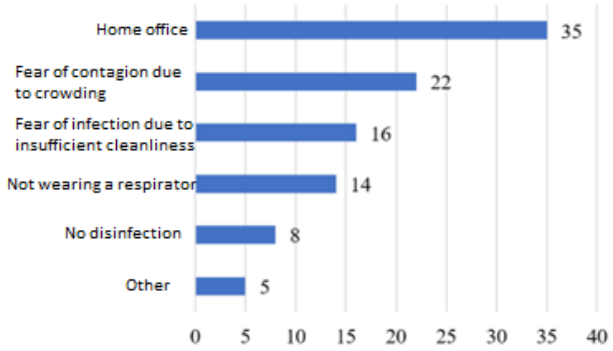


Fig. 8. The reason for reducing the frequency of using public transport (Source: author)

The main factors also included less feeling of personal safety due to crowding (22%) and cleanliness of vehicles (16%). Among the "other" respondents indicated that they would select most of the answers or a few of them, such as disrespecting the wearing of veils by other passengers and overcrowded vehicles.

The use of public transport during the pandemic shows a significant decrease in its users. In many cases, this was due to remote work that did not require daily travel. However, the survey showed that public transport users are concerned about contagion and report the need for additional safety measures, such as the use of disinfectants and improved cleanliness of vehicles, along with the enforcement of face masks. The evaluation of the preparation for the pandemic also pointed out weak points on the part of PT organizers, mentioning personal safety (less crowded vehicles, the necessity of wearing face masks and regular cleaning and disinfection of vehicles).

Conclusion

The aim of this contribution was to obtain more detailed information about the change in mobility behavior from the point of view of personal safety in public transport. We can see direct changes in mobility between the periods before and during the pandemic. Until the COVID-19 crisis, relatively little research has focused on the effects of such pandemics, including their impact on mobility. There are specific procedures in transport, so the COVID-19 pandemic represents an opportunity to reconfigure future transport policy. The results show that people have moved towards a higher use of cars or other forms of active mobility. But on the other hand, the decrease in the use of public transport was also influenced by the transfer of work and school to the household. The main reasons for choosing different types of transport for daily trips are a lower feeling of safety due to the overcrowding of public transport vehicles and the cleanliness of the vehicles.

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