Transport technic and technology
Volume XVIII Issue 1 Year 2022
DOI: 10.2478/ttt-2022-0001

FRAMEWORK PROPOSAL FOR SOLVING PROBLEMS IN RAILWAY TRANSPORT DURING THE COVID-19 PANDEMIC

Abstract. Since the beginning of 2020, the COVID-19 pandemic had a major impact on rail transport in the EU. The slowdown in the spread of the COVID-19 pandemic has been achieved by reducing the mobility of the population. The reduction in mobility has had an impact on passenger transport performance. The number of national rail passengers fell by as much as 90% during the first wave of the pandemic compared to the previous year. Several operators, especially new carriers, had to close down, while rail freight operators reported a dramatic drop in volumes as many sectors slowed or even stopped production as a result of the pandemic. The second wave of the autumn 2020 pandemic has forced many countries to take further restrictive measures regarding population mobility. The outbreak of the third wave of the pandemic has prevented a rapid recovery in rail transport, especially for passenger rail services. The paper focuses on the analysis of the impact of the pandemic and the measures put in place on the development of transport performance in rail transport in the Slovak Republic during the COVID-19 pandemic. The paper proposes operational and organizational measures against the spread of the COVID-19 pandemic in railway transport in the Slovak Republic.
Keywords: measures in railway transport, covid-19 pandemic, railway transport

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Introduction

Rail transport has a crucial role to play not only in the EU's strategy for a sustainable transport sector, but also in terms of economic and social cohesion. It contributes significantly to the mix of transport modes in the EU, while providing clean mobility and a high degree of efficiency. Following the outbreak of the COVID-19 pandemic, the volume of passenger and freight rail transport has fallen sharply due to constraints and lower demand for transport. Several players in the rail market had to close down. Rail operators have had to face a sharp decline in transport services. The effects of the measures introduced during the COVID-19 pandemic, which are related to transport, were addressed in his research by Zhang, et al (2021a). These authors developed a case study focused on the development of COVID-19 transport policy in six developed countries. The case study attempts to provide scientifically based evidence for proposing more effective COVID-19 policy measures in the transport sector. Ding & Zhang (2021) developed a case study focusing on the dynamic relationships between temporary behavioral changes caused by the COVID-19 pandemic and subjective assessments of policy-making.

They reveal the effects of risk perception in the use of public transport during a pandemic. Many researchers and organizations have investigated and reported on the negative impacts of COVID-19 on various aspects of public transportation. Most notably, many cities around the globe have experienced major reductions in public transit demand as a result of the substantially reduced economic activities. Work at home and online business became the new norm after the outbreak of COVID-19 (Zhang, et al., 2021b), contributing to reductions in passenger demand in the range of 80% – 95% (Vickerman, 2021). Modal preferences by commuters were also impacted by the pandemic. For essential out-of-home activities, it was observed that commuters preferred the private car, cycling, and walking over public transit (Gkiotsalitis & Cats, 2021). On the supply-side, many transportation agencies have cut service levels to reduce costs and meet government restrictions on service hours (Naveen & Gurtoo, 2021). Such reductions have consequently contributed to further decline in public transit ridership. It is thus obvious that the COVID-19 pandemic has adversely affected public transit ridership, both directly and indirectly. On the one hand, fewer people were commuting to work and school, and those who commuted were less likely to use public transit due to the perceived health risks while travelling (Tan & Ma, 2020). On the other hand, the restrictions enforced by governments and transit agencies have limited the public transit service levels, contributing to further decline in transit ridership (Marra, et al., 2022).

1. Impacts of the COVID-19 pandemic on railway transport in Slovakia

The impact of the COVID-19 pandemic on the rail passenger transport cannot be fully assessed as the pandemic situation still persists. Nevertheless, anti-pandemic measures are gradually being lifted. What is certain, however, is that the negative economic impact on transport is significant. The decline in the volume of performance of commercially motivated carriers and the consequent financial problems associated with it may result in a reduction in the level of quality of services provided, due to lower competition between carriers. The effects of the first wave of the pandemic were further exacerbated by the onset of the second wave in autumn 2020, when measures to reduce population mobility were reintroduced (European Commission, 2020). Due to the continuing pandemic of COVID-19, the curfew in 2020 and the reduced demand for train transport, the national carrier Železničná spoločnosť Slovensko, a. s. (ZSSK) started optimizing the supply of train transport on 7 March, based on the instructions of the Ministry of Transport and Construction of Slovak Republic, from the first changes to the train schedule diagram. Of the 34.4 million train kilometres planned for 2021, the 917,000 train kilometres will be lost (Ľupták & Pecman, 2021). Traffic in the vicinity of Bratislava was temporarily limited, where even after the reduction, a one-hour train cycle remained in the suburban transport area, which is concentrated during the rush hour to a thirty minute interval between trains. This meant a sufficient and high-quality transport supply due to reduced demand. On the Bánovce nad Ondavou - Veľké Kapušany line section, railway traffic was permanently stopped due to long-term public disinterest (8 trains). The reduction of the scope (or reduction) of transport services is the result of an agreement between ZSSK and Ministry of Transport and Construction of Slovak Republic. The aim was to optimize train supply and public transport expenditure so that the impact of the reduction on the public was minimal given the reduced demand. Ensuring smooth, high-quality and reliable public transport to work or schools by ZSSK trains is still fully implemented (ZSSK, 2020).

In 2020, the global health crisis caused by the COVID-19 pandemic affected the whole of the EU and also had a serious impact on passenger rail transport. In connection with the declaration of an emergency situation in the Slovak Republic, international train traffic with all neighbouring countries was temporarily stopped and the operation of IC trains was also stopped. The operation of all customer centres and the reservation workplace for personal equipment or selected points of sale was also suspended, the sale of national reservations was temporarily suspended and the ordering of restaurant, bed and lounger wagons and car wagons was also limited. These measures have negatively affected the management of the ZSSK and the consequences of the COVID-19 pandemic will continue to manifest itself in 2021 and beyond. Nevertheless, the ZSSK plans to continue ongoing projects in 2021 and to start new projects aimed at saving costs, increasing revenues and quality of services provided, and streamlining activities in the ZSSK (ZSSK, 2020).

2. Development of transport performance during the COVID-19 pandemic

The COVID-19 pandemic crisis has had a major impact on the supply, demand and economic performance of rail transport. The largest impact was recorded in the second quarter of 2020, from April to June. Passenger transport was more affected than freight transport, with international transport falling by an average of 85% in the second quarter of 2020, domestic transport falling by 18%, while freight transport fell by 14% in the second quarter of 2020. The reduction in rail transport in the first months of the crisis was a direct consequence of the public authorities' response to the COVID-19 crisis (restrictions on passenger mobility) as well as the impact of the global economic slowdown, which generally led to a reduction in transport demand. (Slovak Republic, 2020) The number of passenger trains within the public service operated in the network in the period from January to September 2021 is comparable to the number for the same period in 2019, while in 2020 it was by 7.8% compared to 2019 lower. However, the number of commercial passenger trains between January and September 2021 was still 21.5% lower than in the same period in 2019, which means that compared to the same period in 2020, when it was 23.3% lower in compared to 2019, there has been no recovery. The number of freight trains operating on the network was still 2.5% lower than in the corresponding period in 2019. Similar trends can also be observed when expressing the volume of traffic in train kilometres. From January to September 2021, the volume of passenger transport within public interest services expressed in wolf was 5.2% lower compared to the same period in 2019 (Slovak Republic, 2020). Figure 1 shows development of transport performance on Bratislava – Trnava line.

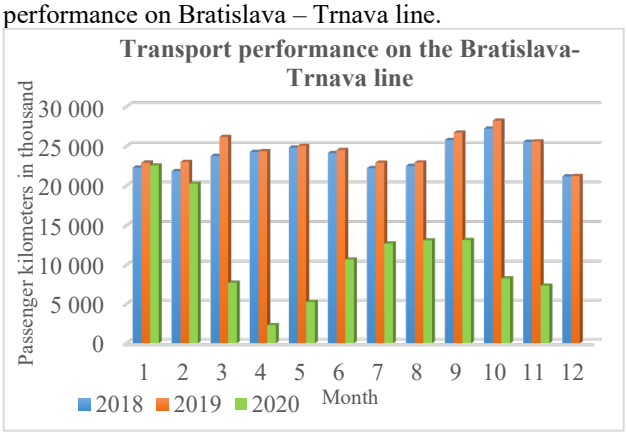


Fig. 1. Development of transport performance on Bratislava – Trnava line (Source: authors according to data from ZSSK)

Commercial passenger transport services expressed in wolf remained in 2021 compared to the same period in 25.6% lower in 2019, which is in line with the (low) level already reached in 2020. As regards the wagons of freight

trains September 2021 remained 2.6% lower compared to the same period in 2019. It follows that the reduced level of rail transport caused by the COVID-19 pandemic still persists.

In passenger transport, performances were significantly affected by the pandemic, which results from the restriction of passenger transport trains, where it was set from 14 March2020 by changing the schedule of public transport, the so-called Saturday's performance regime. The highest decrease in output was recorded in April 2020. Output (train kilometres) in the given month decreased by 37.60% compared to 2019. In figure 2 we can see year-on-year change in transport performance on the Bratislava – Trnava line.

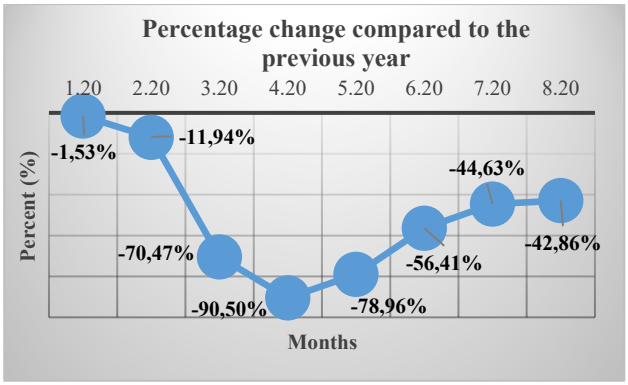


Fig. 2. Year-on-year change in transport performance on the Bratislava - Trnava line in 2020 (Source: authors according to data from ZSSK)

The largest percentage decline in output was in April 2020 and amounted to -90.50%. In May, transport performance began to rise slightly and reached a value of - 78.96%. Performance in passenger kilometres in rail transport also shows that the most significant decrease was recorded in April 2020. The loss of performance measured in passenger kilometres is a direct consequence of a significant reduction in the number of passengers in passenger transport in the period under review. Development of transport performance on Žilina – Čadca line we can see in figure 3.

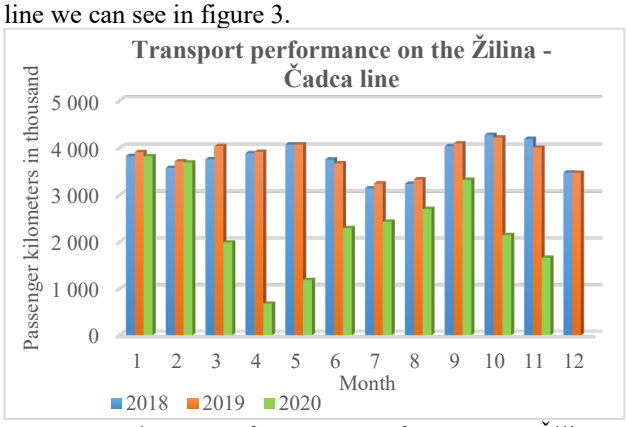


Fig 3. Development of transport performance on Žilina-Čadca line (Source: authors according to data from ZSSK)

Compared to 2018 and 2019, the decrease in transport performance on the regional railway line Žilina - Čadca in 2020 was considerable. April and May were the hardest hit again. After a slight recollection of the first wave of COVID-19, there was another decline in transport performance in November and December, caused by the second wave of the pandemic. Year-on-year change in transport performance on the Žilina - Čadca line in 2020 we can see in figure 4.

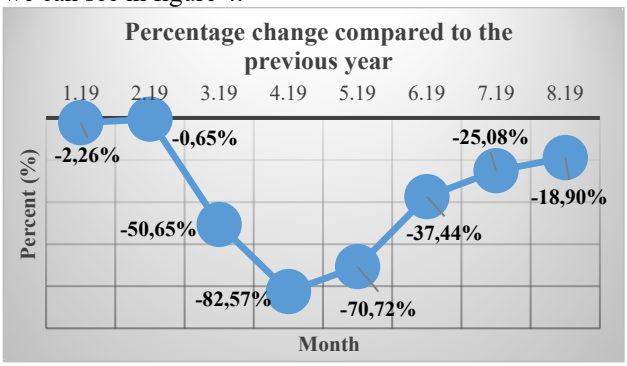


Fig 4. Year-on-year change in transport performance on the Žilina - Čadca line in 2020 (Source: authors according to data from ZSSK)

On the Žilina - Čadca line, the largest year-on-year change in transport performance was from March 2020 to May 2020, with the highest value reaching the month of April (-82.57%). Figure 5 shows development of transport performance on Košice – Humenné line.

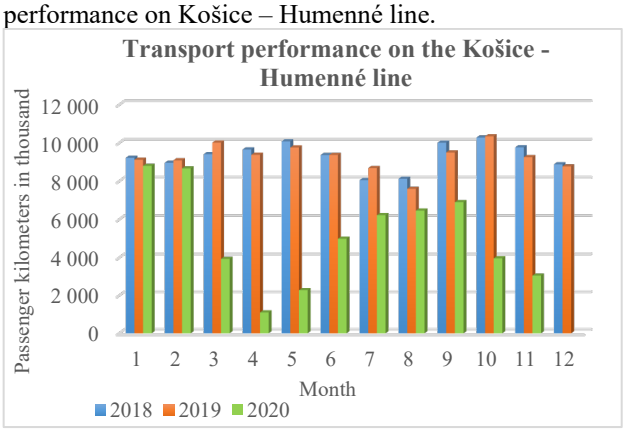


Fig. 5. Development of transport performance on Košice – Humenné line (Source: authors according to data from ZSSK)

In the figure 6 we can see Year-on-year change in transport performance on the Košice - Humenné line in 2020.

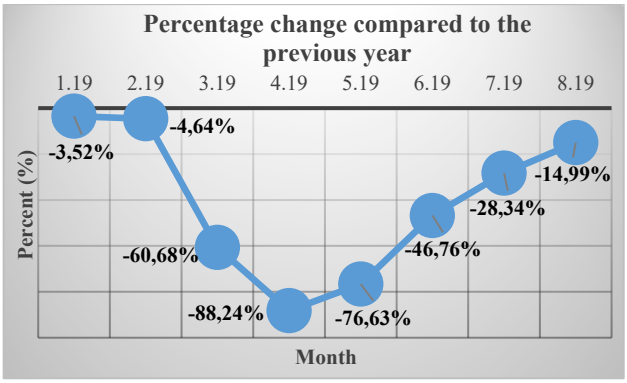


Fig. 6. Year-on-year change in transport performance on the Košice - Humenné line in 2020 (Source: authors according to data from ZSSK)

The largest year-on-year decline was recorded in April 2020 at -88.24% and in May (-76.63%). After these two critical months, transport performance began to rise again. Figure 7 shows the development of traffic performance on the Bratislava - Košice line in the years 2018 - 2020.

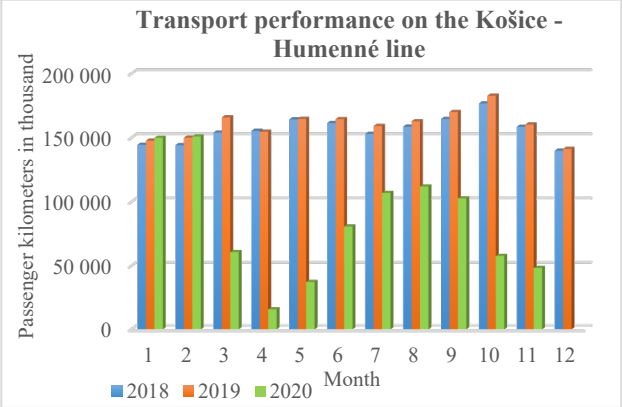


Fig. 7. Development of transport performance on Bratislava – Košice line (Source: authors according to data from ZSSK)

In the picture 7 we can observe transport performance on the Bratislava-Košice line during the years 2018 to 2020. The data show the increasing popularity of long-distance rail transport during 2019 and the first months of 2020. Regular monthly services range between 140 million during less popular months up to the border 180 million during October 2019. Figure 8 shows year-on-year change in transport performance on the Bratislava - Košice line in 2020.

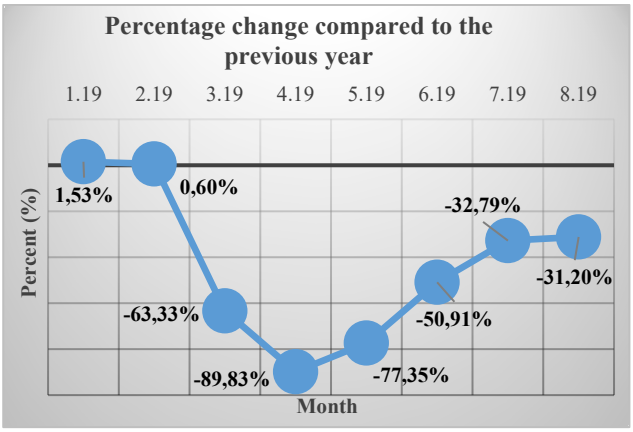


Fig. 8. Year-on-year change in transport performance on the Bratislava - Košice line in 2020 (Source: authors according to data from ZSSK)

During the first months of 2020, the trend of steady growth in transport performance continued. With the arrival of the pandemic in March, we can again observe a two-thirds drop in performance, reaching an absolute bottom in April 2020. The renewed trend is the same as the return trend, but transport performance remained 33% to 31% lower during the summer months by 2019, with passenger numbers only 25 to 22% lower. The reason for the lower performance may be the above-mentioned trend of longer trips during the summer, for example by students from Bratislava back to the east. As colleges remained closed during the first half of 2020, students traveling the entire length of the session remained at home and transport performance was higher. Table 1 shows change in transport performance compared to year 2019.

Table 1. Change in transport performance (passenger kilometres) compared to 2019 (Source: authors according data from ZSSK)

Track section		Bratislava - Trnava	Žilina – Čadca	Košice – Humenné	Bratislava – Košice	Average
Months	1.	2%	-2%	-4%	2%	-1%
	2.	-12%	-1%	-5%	1%	-4%
	3.	-70%	-51%	-61%	-63%	-61%
	4.	-90%	-83%	-88%	-90%	-87%
	5.	-79%	-71%	-77%	-77%	-75%
	6.	-56%	-37%	-47%	-51%	-46%
	7.	-45%	-25%	-28%	-33%	-30%
	8.	-43%	-19%	-15%	-31%	-25%

The COVID-19 pandemic also affected the management of the ZSSK in 2021. In the months of January and February 2021, compared to 2020 (January and February 2020 were not yet marked by a pandemic), we transported 7.9 mil. passengers less (-65.24%), which corresponds to a shortfall in revenues from passenger transport in the amount of 9.2 mil. EUR (-71.24%).

3. Proposal of measures against the spread of COVID-19 in railway transport

The proposed measures against the spread of COVID-19 can also be called operational-organizational measures. We methodically divided them into direct measures and indirect measures. These measures are characterized by the fact that they do not require high investment requirements and are not significantly demanding to implement. Proposal of direct measures shows in figure 9.

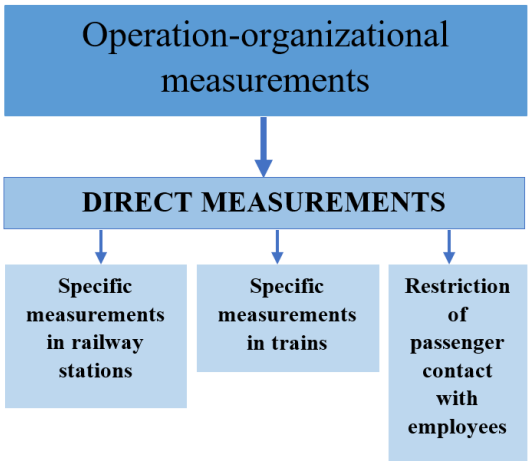


Fig. 9 Proposal of Operation – organizational direct measures (Source: authors)

Direct measures can be divided into specific measurements in railway stations, specific measurements in trains and Restriction of passenger contact with employees.

Figure 10 shows proposal of indirect measures in railway transport.

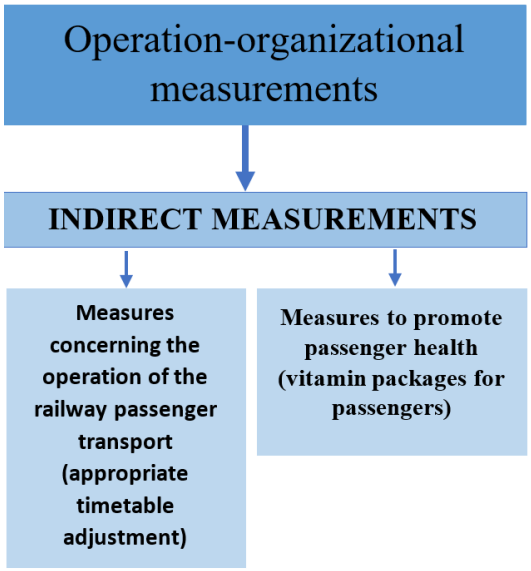


Fig. 10 Proposal of Operation – organizational indirect measures (Source: authors)

Indirect measures can be included Measures concerning the operation of the railway passenger transport and measures to promote passenger health.

3.1 Special free vitamin packages for passengers

As several studies in the field of virology have shown that regular use of the right vitamin composition has a significant effect on the body protection increasing against infections, including SARS 2-Covid-19 and significantly alleviates disease, relieves certain difficulties and accelerates recovery to offer passengers free packages, which will include:

- Vitamin C 250 mg,
- Vitamin D3 2000iu - 30 tablets,
- Selenium, Zinc Forte - 30 tablets,
- 200 ml hand cleansing gel,
- disposable mask (10 pcs/FFP2 type respirators 5 pcs).

These packages will be provided to passengers upon fulfillment of at least one of the following conditions, but not more than once a month:

- after traveling 300 km,
- for daily commuting by train to any distance (in the range of at least 15 calendar days per month).

Package delivery could be done:

- subject to strict anti-pandemic measures at pre-designated locations on or near railway stations (on the basis of a document presented where the passenger proves that he has met at least one of the above conditions, a package will be issued to him at that location),
- distribution to the passenger's specified address,
- distribution to another place (pharmacy in the place of residence), where this package will be issued free of charge on the basis of the submitted document.

The benefits of this operational-organizational measure will lie in particular:

- motivating passengers to make more intensive use of rail passenger transport,
- in motivating passengers to take greater care of their prevention against all viral diseases, which at the same time reduces the risk of their infection during regular train journeys and other means of public passenger transport.

3.2 Modification and disinfection of common areas in wagons and stations

The interior of the vehicle must be suitable for the health safety of the vehicle. This faultlessness is related to influencing the bacterial, viral and fungal microflora to make it as dangerous to humans as possible. Diseased bacteria and viruses enter the air through breathing, talking, but especially coughing and sneezing of passengers. Bacteria and viruses that attach to the wall surface:

- they can find a source of nutrients there,
- they may multiply there if their mass of the means of transport does not affect them,
- are directly destroyed by the mass from which the means of transport is constructed.

In order to ensure health safety, the third mentioned option is optimal, the mass of the means of transport must be adapted to be able to directly destroy bacteria and viruses or other effective measures must be provided that can eradicate these microorganisms quickly and effectively. It is therefore proposed:

a) ensure regular disinfection of toilets and common areas - the authorized employee will disinfect toilets and common areas also during train running at regular intervals (in long-distance trains behind each station / stop);

b) ensure that each passenger disinfects himself / herself in his / her own interest (on arrival and before departure) by means of a disinfection which could be located in each compartment and in each of the four seats in the case of centre wagons;

c) install an automatic air purifier (for example Daikin), which reduces the transmission of droplet infections, while removing common areas of dust, mites, bacteria and especially viruses, using patented Flash Streamer technology, which can destroy 99.93 in a certain area % of common influenza viruses and up to 99.98% of human

coronavirus belonging to the same group as the current SARS-CoV2 virus;

d) install specific microbial destruction equipment, in particular Germicidal lamp, UV disinfection and UV surface disinfection.

The following special equipment could be located:

- at railway stations in common areas and waiting rooms,
- in the wagons of individual trains (in the case of open wagons with an aisle in the middle of 2-5 devices in the wagon; in the case of wagons with a compartment, it is necessary to consider whether it is necessary to place them in each compartment).

However, it may be necessary to manufacture specific types of these devices in order to be able to locate them appropriately.

3.3 Restriction passengers' contact with employees

It is strongly recommended to apply measures to passenger transport processes that limit passenger contact with carriers' employees. It is primarily a matter of limiting this contact at railway stations and on trains.

Measures at railway stations

They consist of limiting passengers' contact with cashiers at personal cash registers, which should be kept to a minimum in this case - this will motivate passengers to buy tickets online (via the internet or via a mobile application), which will also be more advantageous for them in that that they will not have to wait in lines at the cash desks at train stations, but they can comfortably arrive at the station just before the train leaves.

Another measure could be the introduction of turnstiles in the interior of railway stations, underpasses or platforms. These turnstiles would be located in reserved places and each passenger would have to go through them and would only be released after reading a valid travel document. In the case of the introduction of turnstiles, regular checks of travel documents by train drivers would not have to be carried out on trains, but only a random check by inspectors. It would also be appropriate to consider the installation of special devices that would be able to measure the body temperature of passengers before boarding the train, or identify other symptoms of COVID-19 or the possible degree of infectivity of the passenger to their surroundings. These operations could also be carried out at railway stations in the area before entering the underpasses or platforms or before entering the station building by means of a special device (something similar to frames at airports). Each passenger would pass through such a device, and this device would immediately measure his body temperature, or other indicators of his health and, based on the results, he would then be admitted to the platform and on to the train. An alternative solution could be to install a gel disinfection dispenser with body temperature measurement.

Measures in trains

They consist mainly in limiting contact with the train staff, which will also be due to the lack of train drivers in the ZSSK and. with reduced to a minimum. The control of travel documents will take place on the train in such a way that an automatic QR code reader of travel documents will be placed in each wagon above each seat, while the passenger will scan his travel document before the sitting in a specific seat. After the travel document has been scanned, a green light will illuminate above the place. If a valid travel document is scanned but in the wrong place, the light will turn yellow and if no travel document is scanned, the light will turn red. However, this progressive system can only be introduced in the case of mandatory local train connections. Subsequent checks will be carried out by an auditor or other authorized employee, and only in the case of such passengers, whose control indicator over their seat will not turn green. This measure could serve as an alternative to the introduction of turnstiles at stations.

3.4. Introduction of mandatory seats and limitation of the capacity of individual train connections

If certain measures are put in place to help reduce the mobility of citizens, and thus a reduction in passenger frequencies can be considered, it will also be possible to reduce the capacity of individual train connections. This measure could also only be implemented if mandatory train seats are introduced. The individual alternatives could be the following:

- limiting the capacity of wagons to 50% - filling every other seat in wagons with compartments (max. three passengers in one compartment) as well as in wagons with an aisle in the middle (max. two passengers in one "four");
- limitation of wagon capacity to 33% - occupancy of every third seat, applicable especially in wagons with compartment compartments (max. two passengers in one compartment);
- limitation of wagon capacity to 25% - occupying every fourth seat, applicable especially in wagons with an aisle in the middle (max. one passenger in one "four");
- as a last resort, limiting the capacity of wagons with compartments to 16.67% (max. one passenger in the compartment);
- the placement of a specific glass wall in compartment wagons, which would be mounted through the middle seat in both rows, thus achieving better protection for passengers and at the same time more space and privacy for them - in this case the capacity of these wagons could be limited to 66.67% (max. four passengers in the coupe);

- placement of a specific glass wall also in wagons with an aisle in the middle, between the individual fours, or pair of seats (in this case 50% of the capacity in these wagons would be recommended).

This measure can be applied especially in long-distance transport, in regional transport it is significantly more complicated. However, capacity constraints could also take into account the groups in which the passengers travel (whether the passenger is alone, a couple, or a family or a larger group). Based on this, coupe compartments could be reserved for families or groups of people.

The implementation of the most of the above proposed measures will have a major impact on employment in the rail passenger transport sector. As a significant reduction is considered, or absolute abolition of train managers and personal cashiers, it will be necessary for these staff to find an alternative job. They could find application, for example, as special inspectors on trains, checking only those passengers who did not read their travel document correctly (their indicator light would not turn green), and they could also help to disinfect trains and stations and to check passengers when crossing the turnstile, or body temperature measuring device. They could also work as operators who could assist in the electronic sale of travel documents and also in organizing the distribution of vitamin packages for passengers.

Another group of measures could be **construction and renovation measures** (see Figure 11). These measures are technologically, time and financially more demanding.

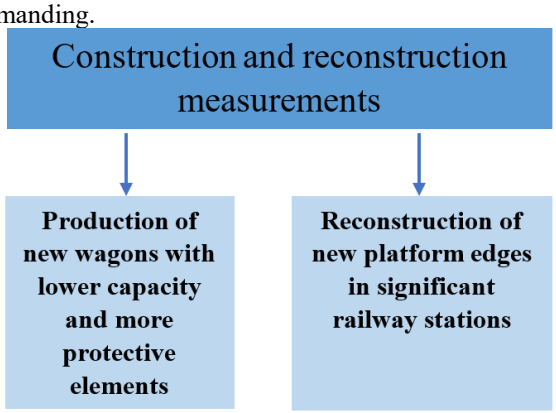


Fig. 11 Proposal of construction and reconstruction measures (Source: authors)

The proposal of construction and reconstruction measurements contains production of new wagons with lower capacity and more protective elements and reconstruction of new platform edges in significant railway stations.

Conclusion

During the first wave of the pandemic, rail transport in Slovakia suffered a significant drop in transport performance. With the declaration of the global pandemic and a state of emergency in the Slovak Republic in March 2020, we can observe an average drop in performance on all routes by 61%. The sharp decline in output continued until April, when it stopped at an average of 87%.

The positive effects on rail transport in the Slovak Republic have been evident for several years. The number of passengers grew every year before 2020 and it can be assumed that after the end of the pandemic, the growth trend will resume. Functioning railway connections within the Slovak Republic offer a suitable alternative to the individual car transport for transfer between regional cities. There is a presumption that with the resurgence of cars on the roads, potential passengers will find their way back to rail transport. The European Union's efforts to reduce emissions through the financing of greener modes of transport provided by rail can also contribute to long-term positive developments. With the gradual reconstruction of lines from sources partially provided by the European Union, the competitiveness of train transport in Slovakia may increase. The negative effects of the pandemic are more of a short-term threat to rail transport. Weakened passenger confidence in the sterility of trains and stations is unlikely to persist for more than half a year after the end of the pandemic. The transfer of passengers to the individual car transport, combined with the effort to avoid human contact, will no longer be an attractive option with a large number of cars returning to the roads and opening up the economy.

Acknowledgement

This publication was created thanks to support under the Operational Program Integrated Infrastructure for the project: Identification and possibilities of implementation of new technological measures in transport to achieve safe mobility during a pandemic caused by COVID-19 (ITMS code: 313011AUX5), co-financed by the European Regional Development Fund.

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