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INCREASING THE QUALITY AND EFFICIENCY OF THE TRANSPORTATION PROCESS IN RAILWAY PASSENGER TRANSPORT IN THE CASE OF ANOTHER PANDEMIC PERIOD

Abstract. During the individual waves of the COVID-19 pandemic, several areas have been significantly changed in our society. Especially during its first wave in the spring of 2020, lockdowns began to be introduced practically overnight and several strict anti-pandemic measures were adopted in most countries of the world, which changed the lives of all residents. The mentioned changes also significantly affected the public passenger transport sector and the transport process. Many times, they were implemented into practice immediately without conceptual systematic preparation. This contribution is focused on a progressive proposal of measures to improve the quality and efficiency of the transport process in railway passenger transport in the next potential period of the pandemic. In the process of providing a passenger with a travel document during the pandemic, new technical and technological elements are implemented in railway stations and trains to reduce the risk of virus transmission in order to protect the health of the passenger and the carrier's employees. By introducing more modern passenger equipment systems in railway passenger transport in the form of automation and digitization of processes, it is possible to streamline and improve the quality of the transport process.
Keywords: railway passenger transport, post-pandemic period, transportation process, quality, efficiency

Zdenka Bulková[1]
[1] *Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina; +421/41 513 3411; zdenka.bulkova@uniza.sk*
Milan Dedík[1]
[1] *Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina; +421/41 513 3413; milan.dedik@uniza.sk*
Michal Lovíšek[1]
[1] *Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina; michal.lovisek@lte.sk*
Katarína Janošková[1]
[1] *Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina; +421/41 513 3233; katarina.janoskova@uniza.sk*
Juraj Vaculík[1]
[1] *Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina; +421/41 513 3132; juraj.vaculik@uniza.sk*

Introduction

Public mass transport systems are exposed to many external factors that affect their functioning. One of them can be an epidemiological threat. In 2020, the global COVID-19 pandemic had a significant impact on the world economy and passenger transport (Czodörová, et al., 2021). Numerous imposed restrictions affected demand (number of passengers) and supply (number of connections) in the transport market (Ma, et al., 2023). The most common restrictions included limiting the number of connections, reducing the limit of passengers in a vehicle, limiting the network of transport connections, etc. (Shortall, et al., 2022)

Public transport, especially rail passenger transport over long distances and large areas, is the most potential risk source of the pandemic. Anti-pandemic measures were mainly manifested in the reduction of population mobility in public passenger transport (Dingil & Esytergár, 2021) and in changes in mobility at the regional level. In the Slovak Republic, this change manifested itself to varying degrees. Specific research evaluated the mobility of changes at the regional level (Konečný, et al., 2021). In the USA (n = 50) and in selected regions of the world (n = 133), the results differ in the number of residents who follow the measures, but especially in the first wave of the pandemic, these groups were more numerous than the groups of people who did not follow the government's restrictions on movement. Another interesting group of travellers who influence mobility are students. In the article (Cairns & Franca, 2022), the authors deal with the mobility of foreign students, since one of the basic measures of the first waves of the pandemic was the closing of borders. The safe environment of public transport is a question even after the pandemic. In the article (Ulahannan & Birrell, 2022), the authors, based on a questionnaire, examine the preferences of passengers in public transport, which were affected by the COVID-19 pandemic. There are also lots of interesting contributions and other publications (Naveen & Gurtoo, 2022; Molin & Karesen, 2022; Chan, et al., 2020; Wielechowski, et al., 2020; Huang, et al., 2020) which deal with the mentioned topic.

The aim of this contribution is to propose a set of anti-pandemic measures to improve the quality and efficiency of the transport process in railway passenger transport in the next period of the pandemic. The proposal determines three levels of measures on the part of the state, operational

and organizational measures on the part of the carrier and the infrastructure manager, and also determines the process of equipping the passenger from the purchase of the travel document to the end of the transport. The proposed flowchart of the process of equipping the passenger determines the successive steps of equipping the passenger with a travel document together with the implementation of new technical and technological elements in railway stations and trains to reduce the risk of spreading the virus. The aim of introducing these elements is to ensure safe passenger equipment, safe passenger transportation and employee protection by reducing the risk of spreading the virus during the entire process, as well as the introduction of more modern passenger equipment elements in the form of automation and digitization of processes.

1. Changes and milestones in transport due to the influence of the Covid-19 disease

Many countries have taken various measures to stop the spread of COVID-19. Among the most important of these is the use of social distancing to prevent contact. Limited social contacts have a significant impact on activity participation and travel demand (Beck, et al., 2020). The availability restrictions adopted by many countries were a quick but effective response to limit the spread of the virus and to make passengers feel safe traveling by rail. Anti-pandemic measures were also reflected in the reduction of population mobility in rail passenger transport (Dedík, et al., 2022) and in changes in mobility in long-distance transport and regional (Laroche, 2022; Smolarski & Szuszczewicz, 2021). Figure 1 shows the development of the number of transported passengers in rail passenger transport in the Slovak Republic in the period 2019-2022.

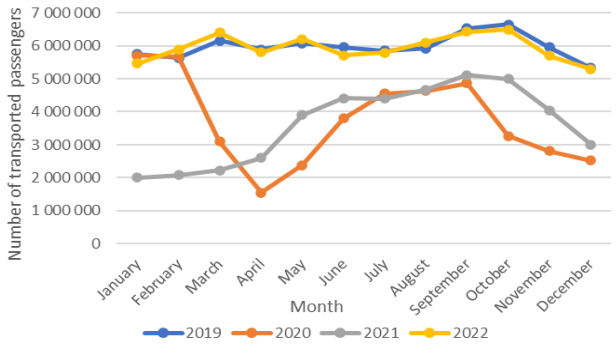


Fig. 1. Development of the number of transported passengers in railway passenger transport in Slovakia (authors)

Due to the significant change in society that occurred in the world at the beginning of 2020 with the outbreak of the COVID-19 pandemic, the behaviour of people in almost all areas of life has changed significantly. In the field of passenger transport, many different measures were implemented within a few days, the aim of which was to reduce the risk of infection with the disease COVID-19 in all types of public passenger transport (Bulková, et al., 2022). The impacts of some measures had a societal impact. The most significant changes and milestones in the field of transportation are listed below.

The impact of some measures has had a societal impact and consequences of several of them persist to this day. The most significant changes and milestones in the field of transport are presented in the following subchapters.

1.1. Implementation of health protection measures in transport means and common areas

- ensuring greater cleanliness and disinfection in transport means and public spaces,
- omitting 2 rows of seats behind the driver,
- recommending that passengers sit as far apart as possible and observe certain spacing,
- door opening in demand,
- wearing masks, protective equipment, etc.,
- ozone cleaning was also carried out at least once a day and after the end of the connection.

1.2. Significant change in traffic behavior and traffic conditions

- the main reason was the introduction of measures and restrictions on movement (lower people mobility, more home office, limited and cancelled mass events, etc.,
- the fear of COVID-19 infection was also a secondary cause,
- the result was a performance decrease of public passenger transport at the expense of the individual car traffic,
- there has also been an increase in non-motorized services.
- free city public transport services have been introduced temporarily to protect the health of passengers (so that they do not have to meet the driver, money, payment cards, etc.) in certain cities,
- there was also limited control and revision of travel documents in some trains.

1.3. Significant change of work habits

- significantly higher utilization of the home office and online activities,
- shorter, more flexible, and more distributed working hours.

1.4. Increase in online activities

- the transfer to the home office in many employers (partial or full),
- online communication through various applications,
- most employees found this positive, many activities becoming more efficient and dynamic; travel time has been saved (from work, to work, to travel on business trip),

- a new space has been created for the negotiation of several employees from several institutions; this is a very effective way of communication for the future,
- however, home office and online communication also have disadvantages (impersonal communication, outgoing signal, etc.).

1.5. Crisis management strengthening (rapid decisions)

- crisis headquarters were immediately set up in several institutions (infrastructure managers, carriers, transport undertakings, etc.) where very rapid, operational, and flexible decisions were taken,
- various alternatives have been developed to deal with different scenarios,
- something new had to be tackled every day, individual activities had to be stepped up,
- it was important to find an optimal solution, as it was necessary to limit mobility while ensuring of the critical infrastructure functioning, as well as the transit of goods across borders and so on.

1.6. Faster implementation of the new technological wave (digitalization)

- measures and recommendations were made to use the card (payment or transport), passengers could obtain a free card during the European Mobility Week,
- the implementation of marketing activities that can also be paid by mobile phone (mobile card) or other progressive ways.

1.7. Increased support for non-motorized transport

- increasing people's interest in walking and cycling as an environmentally friendly and healthy alternative with a minimal infection risk,
- speeding up the construction of infrastructure for cycling, walkways, etc.

1.8. Broader contexts of the mentioned issue

- in the times since the beginning of the pandemic, a trend of suburbanization was noted,
- moving more to the countryside - also due to more frequent Home-Office,
- support for the construction of more greenery in cities (correlation with the health of the population).

1.9. SWOT analysis

Individual changes and milestones caused by the COVID-19 pandemic are expressed in table 1 using a brief SWOT analysis, where strengths and weaknesses, opportunities and threats are described.

Table 1. SWOT analysis of individual changes and milestones caused by the Covid-19 pandemic

Strengths	**Weaknesses**
Higher security Higher health protection Positive contexts of Home-Office and online activities	Significant reduction of connections Lower transport performance Significant sales shortfalls Absences of operational staff
Opportunities	**Threats**
Support of non-motorized transport Support of special progressive transport systems A higher degree of digitization in passenger transport (more online activities) Crisis management support Changes in traffic behaviour and work habits	Loss of attractiveness of public passenger transport Potentially increasing congestion Implementation of quick decisions Poor socialization of Home-Office employees

2. Framework proposal for anti-pandemic measures in rail passenger transport during the next pandemic period

There are specific types of restrictions and measures in railway passenger transport in figure 2, which are proposed as a framework for the introduction of individual degrees of restriction of people's mobility. The proposals pay particular attention to the quality of the connections (Ľupták & Pecman, 2021). The 0th degree will be a status with no changes.

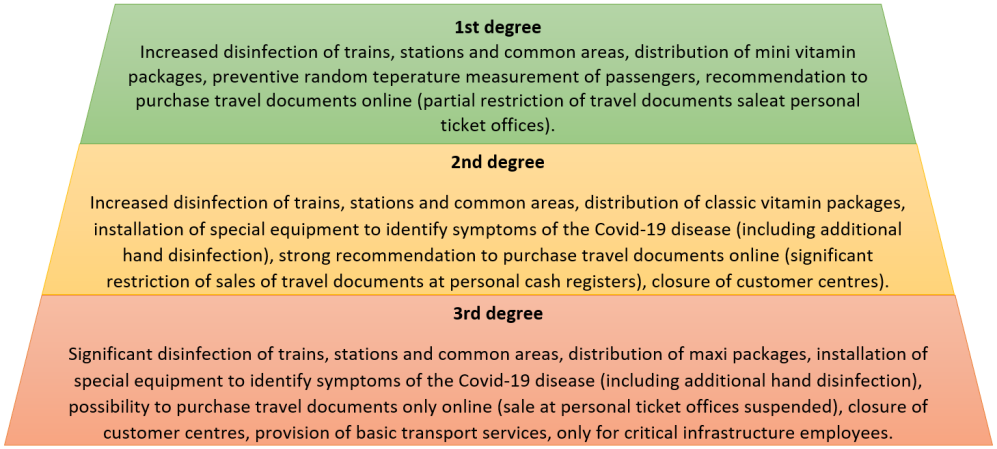


Fig. 2. Degrees of restrictions of people´s mobility (authors)

It is also important to point out the necessity of reducing train connections in the event of the introduction of the mentioned measures. However, it is also necessary to distinguish regional and suburban, as well as long-distance or international railway passenger transport. Each of the listed types has its own specifics and ensures the satisfaction of the needs of other groups of passengers. The proposal for the reduction of transport types within individual levels of measures is presented in Table 2.

Table 2. Proposal to reduce train connections in the next period of the pandemic (authors)

Level	Number of connection reduction		
	Regional and suburban rail passenger transport	**Long-distance rail passenger transport**	**International rail passenger transport**
1	10%	20%	30%
2	20%	30%	50%
3	30%	50%	100%

As an example, we can cite the extent of the reduction of train connections in long-distance transport, which is shown in figure 3. The figure shows that in the case of the introduction of the highest level of measures, the number of train connections in long-distance transport will be significantly reduced, i.e. by 50%.

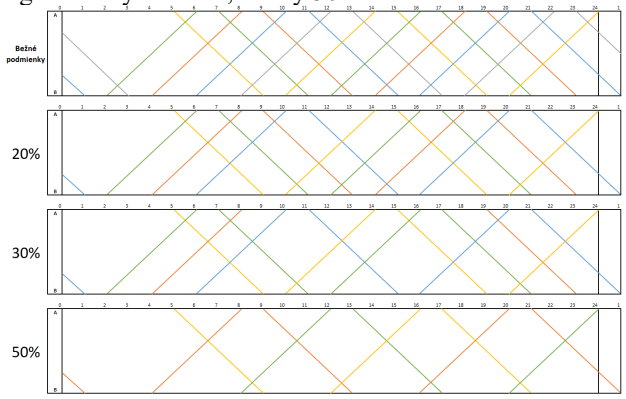


Fig. 3. The extent of the reduction of train connections in long-distance transport (authors)

In the case of regional and suburban transport, the reduction of train connections will not be so significant. On the contrary, in international transport, when the highest 3rd level of measures is introduced, transport will be completely interrupted. Figure 4 shows reduction of train connections in regional transport.

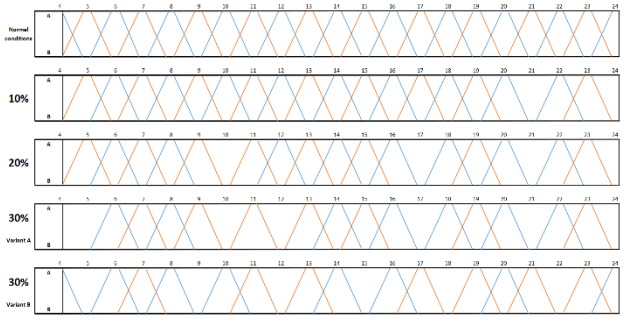


Fig. 4. Impact of introduced measures on the regional railway operation (authors)

3. Procedure for equipment of passengers in rail passenger transport in the case of the highest degree of anti-pandemic measures

As part of the introduction of the highest level of anti-pandemic measures, the following procedure for individual activities will be recommended for passengers in the case of using rail passenger transport:

- purchasing a travel document online,
- reading the travel document through the turnstile before entering the station building,
- passage of the passenger through a special device for identifying symptoms of the COVID-19 disease (including additional hand disinfection),
- boarding of the passenger on the train,
- the passenger scans his/her travel document (above compartment),
- each passenger, in his/her own interest, disinfects the area where he/she is sitting (after arriving at the place),
- passengers receive a free vitamin package (mini, classic, maxi),
- each passenger, in his own interest, disinfects the area where he/she is sitting (after leaving it),
- exit of the passenger from the train.

Figure 5 shows the process of equipping a passenger in rail transport in the event of the introduction of the highest level of anti-pandemic measures, from the purchase of a travel document to the end of the transport process.

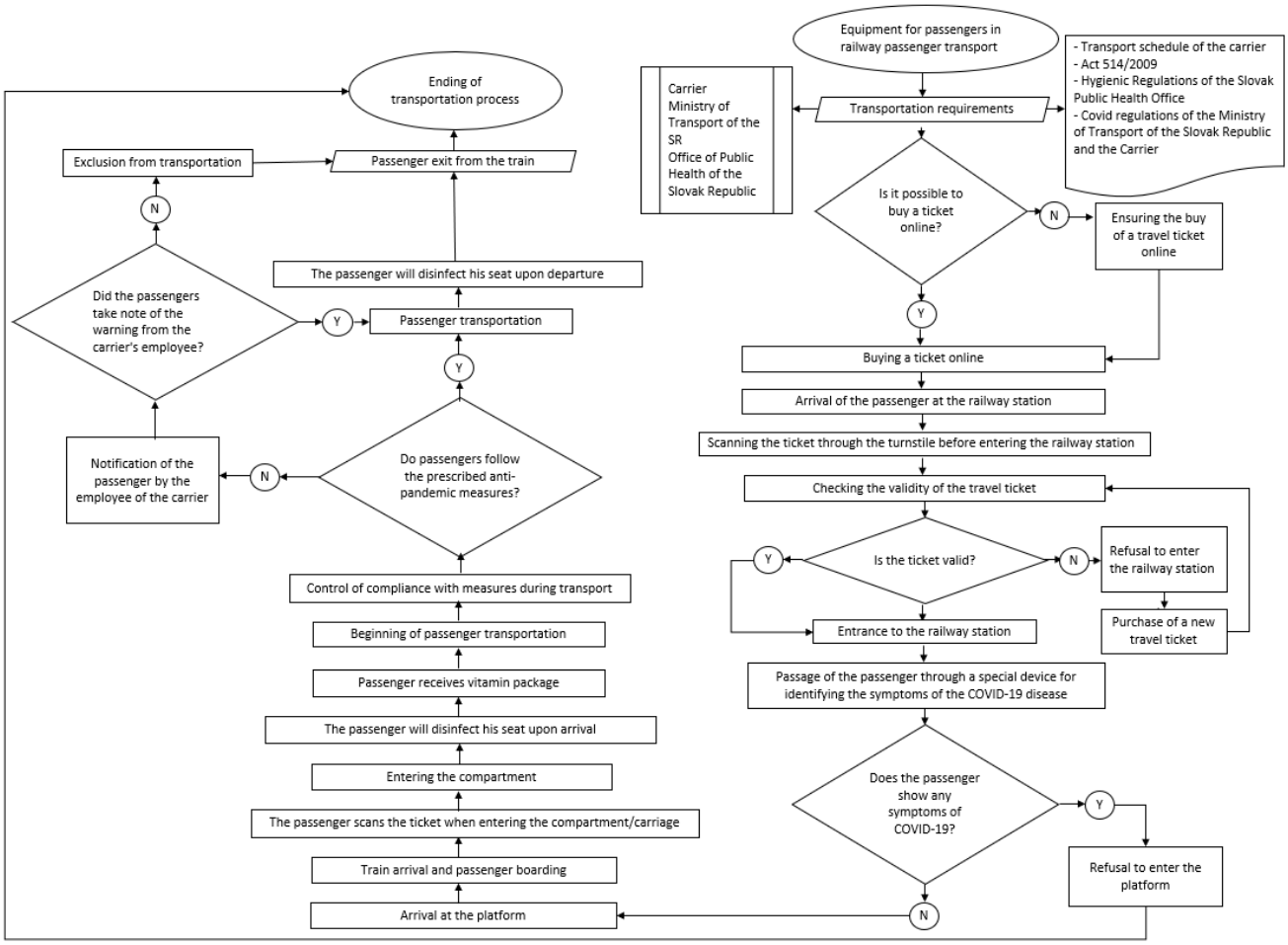


Fig. 5. Equipment for passengers in rail passenger transport in case of the highest level of anti-pandemic measures (authors)

The proposed passenger fitting process emphasizes the safety of the passenger and the carrier's employees by reducing contact between the passenger and the carrier's employee (guide) and will reduce the risk of disease transmission.

Conclusion

Guaranteeing an adequate level of safety in the conditions of an epidemic is a very problematic issue due to the subjectivism of social individuals, their diverse attitudes and past experiences. The paper analyses the changes in transport caused by the Covid-19 disease and related measures introduced in Slovakia, including their impact on railway passenger transport. Based on available materials and used methods, a new system and procedure for introducing anti-pandemic measures at three levels was developed to support and develop not only rail passenger transport, but also public passenger transport in the next period of the pandemic. Especially in the field of railway passenger transport, it is necessary to implement several measures to increase its efficiency and attractiveness.

The proposed procedure for equipping a passenger in rail passenger transport, in which new technical and technological elements are implemented, serves to ensure a reduction in the risk of virus infection, increase the safety of passengers and employees and introduce more modern systems for equipping a passenger with a travel document (for example, mobile applications for purchasing a travel document, self-service Kiosks and so on). The basic intention is to maintain high-quality, safe, sustainable and reliable public passenger transport even during such an emergency situation. It is very important to properly protect passengers and employees from illness and at the same time motivate them to make maximum use of public passenger transport even during the pandemic.

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